SCIENTIFIC AMERICAN
No. SUPPLEMENT 241

Scientific American Supplement, Vol. X., No. 241.
Scientific American, established 1845.

NEW YORK, AUGUST 14, 1880.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

Figure 1.

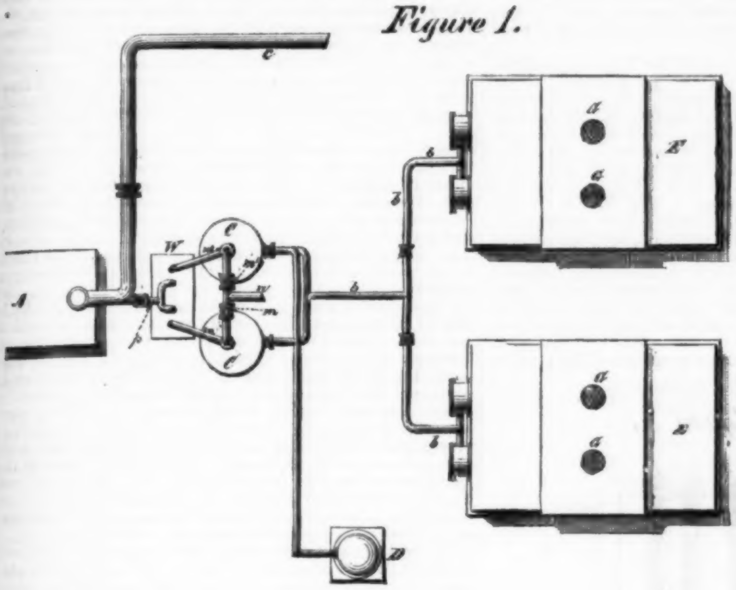


Figure 2.

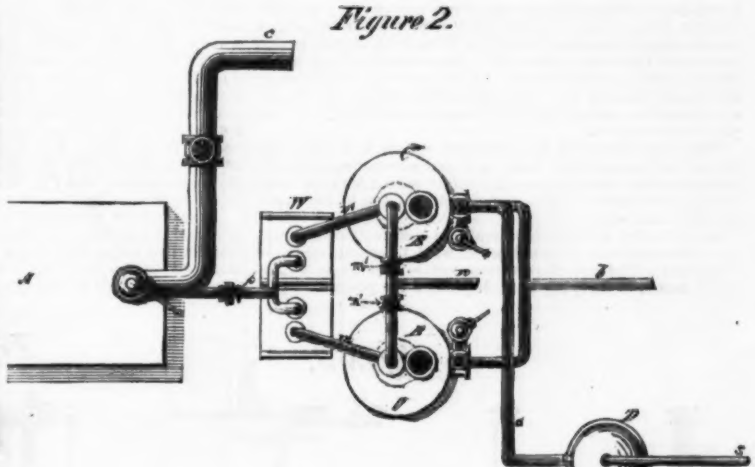


Figure 5.

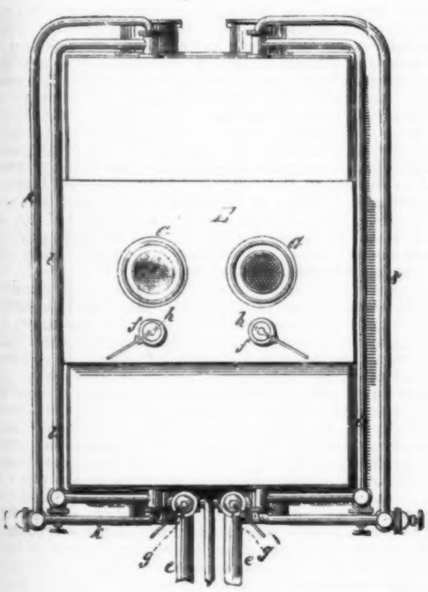


Figure 3.

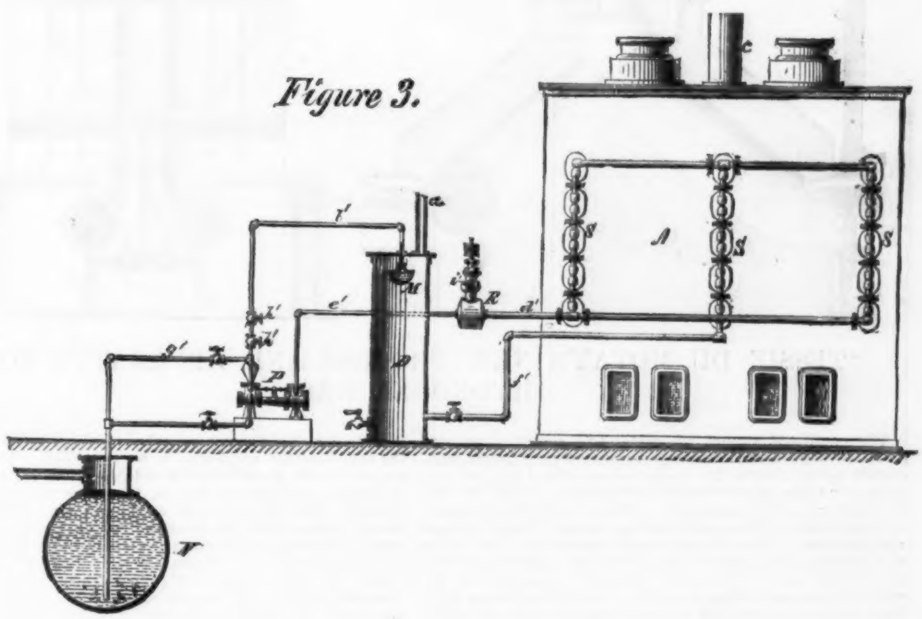


Figure 6.

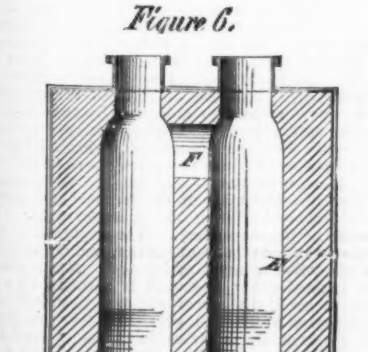
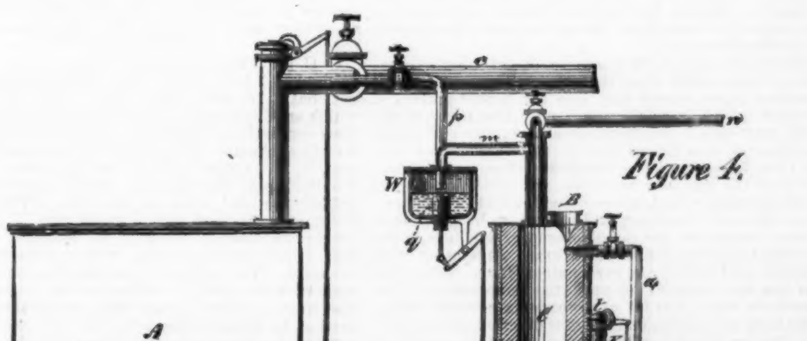


Figure 4.



TESSIE DU MOTAY'S NEW PROCESS AND APPARATUS FOR HYDROGEN GAS.

PROCESS AND APPARATUS FOR PRODUCING HYDROGEN GAS.

By the late Cyprien Marie Tessié Du Motay, of Paris, France.

My process has relation to the production of hydrogen by the conversion of superheated steam carrying with it a certain amount of vapor of naphtha, or its equivalent, in the presence of highly-heated lime, which causes the conversion of said lime into carbonate of lime; and also of the subsequent reconversion of said carbonate of lime into lime, enabling the process, by means of two furnaces, to be continually carried on.

The conversion of the carbonate of lime into lime is accomplished by highly heating such carbonate of lime in the presence of a certain amount of water or steam, the gases resulting from this reaction being allowed to escape.

By means of the apparatus shown hydrogen gas can be continuously produced by the employment of two sets of superheaters and two converting-furnaces, which can be alternately used.

The principal features of the apparatus by which my process is carried out are, in the first place, a generator capable of producing carbonic oxide. This carbonic oxide, passing from this apparatus, is partly used for heating the steam-boiler which supplies the steam necessary in the subsequent steps of my process, and is partly carried into a superheating apparatus, which is filled with highly-heated masses of refractory material. This superheater is made double, having two chambers, so that one may be heated by the combustion in it of carbonic oxide and air, while the other is being used to heat the steam and naphtha which are passing through it.

This hydrocarbon in the apparatus shown is fed into the top of the superheater from a vessel containing it by the flow of steam, which comes in contact with a spray of such naphtha and carries it in suspension to the top of the superheating-chamber.

Any form of hydrocarbon could be used for this purpose, and various means of mingling it with the steam could be employed. The one shown, however, is a convenient and ready means of carrying out this part of the process.

The combined vapors of water and naphtha, passing down through a superheating-chamber which is not sufficiently hot to convert the naphtha into a fixed gas, are subsequently taken to the converting-furnaces, which are two in number in my apparatus. These converting-furnaces are preferably of the construction shown, which is somewhat peculiar. They do not consist either of a vertical or of a horizontal chamber or chambers, but each furnace consists of two halves or separate chambers connected at one end and disconnected at the other. As shown in the drawings, these chambers are in the form of a bent cylinder, being highest in the middle and lowest at the two ends, their bottoms, forming two inclined planes, allowing the feeding of the lime into them through a central feeding-aperture in either direction.

The furnace is made in two parts, with the object of having one portion cooler than the other. The mixed steam and naphtha vapor passes first into the hottest portion of this furnace, which is filled with lime. The result of the chemical reaction of this highly-heated mixture of steam and naphtha with the heated lime is the production of hydrogen in a free—that is, uncombined—state by the transformation of the gas into hydrogen and carbonic acid, the latter being simply mixed, not combined, with the hydrogen. This carbonic acid is subsequently taken up by the lime in the cooler portion of the double furnace, the lime in the first portion being too hot to enter into combination with the carbonic acid and form carbonate of lime. After this process has been carried on until the temperature of the lime has been reduced so far as to render a cessation advisable, the flow of naphtha and steam is diverted into another similar furnace, which has been in the meantime heated in a manner to be described. This is done by introducing into that end of the double furnace where the lime has been converted into carbonate of lime a stream of gas containing a certain amount of water, or capable of producing by its combustion a certain amount of water and a stream of air.

The gas used in this reconversion of the carbonate of lime into lime can be obtained from the gas-generator previously spoken of as producing carbonic oxide by using such gas-generator for the production of carbureted hydrogen or other gas containing a certain amount of hydrogen; or a separate gas-generator might be employed for this purpose, the essential qualities of the gas so used being that it must be capable of combustion at a high temperature, and at the same time of bringing in contact with or in the presence of the carbonate of lime a certain amount of water, or water in the shape of steam. It is the reconversion of the carbonate of lime into lime which I consider the most important improvement in this process. The use of a current of steam, carrying with it a certain amount of naphtha or equivalent hydrocarbon, and its conversion into hydrogen in the presence of lime, is also, I believe, new in this process.

There is an essential difference between the resulting products of steam and naphtha which have come in contact with heated brick or other similar substance and the resulting products of the same substances passed over heated lime, the products, in the first instance, being, essentially, carbonic oxide and hydrogen, and in the second instance carbonic acid and hydrogen. In both cases other impurities are present. The reaction and decomposition likewise take place at a lower temperature in the presence of heated lime than of heated brick, and there is, therefore, much less danger of burning the naphtha and making lamp-black, which is one of the most serious difficulties encountered in the production of combustible illuminating-gas.

It is obvious that many forms of apparatus can be used in carrying out this invention, and the apparatus which I shall describe is only one of many forms which might be devised for this purpose.

Figure 1 represents a plan view of the entire apparatus; Fig. 2, a more detailed view of the gas-generator, superheaters, and naphtha-supply apparatus. Fig. 3 represents a view, partially in section, of the naphtha-supply apparatus, the naphtha-tank, and the steam-superheating apparatus. Fig. 4 represents a view, partially in section, of the naphtha-supply apparatus, the gas-generator, one of the superheaters, and the necessary connections. Fig. 5 represents a top view of the converting-furnaces; Fig. 6, a horizontal section of the same; Fig. 7, a vertical section through one of said furnaces; Fig. 8, a front elevation, showing some of the connections; and Fig. 9, a view, partly in section, showing a method of igniting the gas in the converting-furnaces.

A represents any one of the well-known forms of gas-generators capable of producing carbonic oxide, or, preferably in this apparatus, either carbureted hydrogen or carbonic oxide carrying with it a certain amount of hydrogen. The gas produced in this generator is carried off by pipes, *c*, to a boiler (not shown), or, when desired, by pipes, *p*, to the superheating apparatus, to be described. These pipes are, of course, provided with suitable valves for the control of the gas, as is indeed true of the other pipes of the apparatus. Two valves are shown in the pipe, *p*, Fig. 4, one being a screw-valve, by means of which the amount of gas passing through can be controlled, and the other is shown in the water-seal, W. From this water-seal two pipes, *m m*, lead to the superheaters, and each of them is provided with a water-seal cup, *q*, by means of which the flow of gas from the generator, A, can be diverted from either one of the superheaters; but these valves and other arrangements are matters of detail, which I do not claim in this application, since they may be supplied by any intelligent gas-engineer.

C C are two superheaters, which may be alternately used when it is desired to keep up a constant supply of the gas; but it is plain that all the parts in this apparatus which are duplicated might be used singly in case a continuous supply is not requisite. This superheater consists in a vertical chamber provided with appropriate supply-openings, B. The pipe, *m*, from the gas generator, A, delivers into the top of this chamber, which is filled with some refractory material, such as fire-brick. The bottom of this chamber is provided with a purge-pipe, K, Fig. 4, opening into the chamber by means of the aperture, L. This purge-pipe is, of course, provided with a suitable purge-valve, *t*, as shown. The bottom of the chambers communicates likewise with the pipe, *b*, leading to the converting-furnaces. The pipe, *n*, which enters the superheater, C, at its top, passing in through the center of the gas supply pipe, *m*, supplies a sufficient quantity of air for the proper combustion of the gas produced in the generator, A. Superheater, C, is also provided with a steam-supply pipe, *a*, which communicates with the carbureting apparatus, D. (Shown more fully in section in Fig. 3.) This apparatus consists of a chamber, D, provided with a rose-spray, M, supplied by pipe, *b'*, from pump, P, which takes the naphtha from the supply-tank, N.

The generator, A, may be provided with superheaters, S, and steam from a boiler (not shown) passes, by pipe, *i*, through a regulating-valve, R, which automatically controls the pressure. Passing through this valve, it divides, part going by pipe, *d*, to superheaters, S, and part by pipe, *c'*, to pump, P, so that the steam which operates the supply pump and which passes through the superheaters is regulated by the same valve, and an increased flow of steam would be accompanied by an increased flow of naphtha. The steam passing through the superheaters arrives at the carbureter by the pipe, *f*. When moving upward it is met by the supply of naphtha from the rose-spray, M, which it carries off in suspension by the pipe, *a*.

g' represents a by-pass pipe, by which the supply of naphtha can be entirely cut off by allowing it to return to the tank. Two valves, *h'*, are also shown, by means of one of which the supply can be regulated, and by the other of which the supply could be shut off entirely without altering the regulating-valve previously set. The superheated steam and naphtha, passing out by the pipe, *a*, are delivered into the top of the superheater, C, as shown in Fig. 4.

The connections are somewhat differently arranged in the different figures; but this is a matter of small importance, and may be arranged to suit the circumstances of the works.

The pipe, *b*, previously described, communicates with a pair of converting-furnaces, E. These furnaces are fully shown in Figs. 1, 5, 6, 7, 8, and 9. Each furnace consists of a double chamber, as is clearly shown in Fig. 6. These chambers are each in the form of a bent or broken cylinder or inverted V, or of two inclined cylinders, as is shown in Fig. 7. Each of these chambers is arranged with a supply tube, G, at the top, by means of which lime is fed to it. This lime, being fed from the central apex, supplies both ends of the chamber. Escape-pipes, *f*, are also provided for use, to be described. They are arranged with valves, *h*. The mixture of steam and naphtha coming from the superheaters by the pipe, *b*, passes into either one of the chambers of either furnace by means of a divided pipe, its course being determined by suitable valves. Its entrance into either one of the chambers of the converting-furnace is determined by valves, *j*, Fig. 8. Both ends of these chambers are provided also with gas and air pipes, for the purpose of introducing into the same and burning a mixture of gas and air.

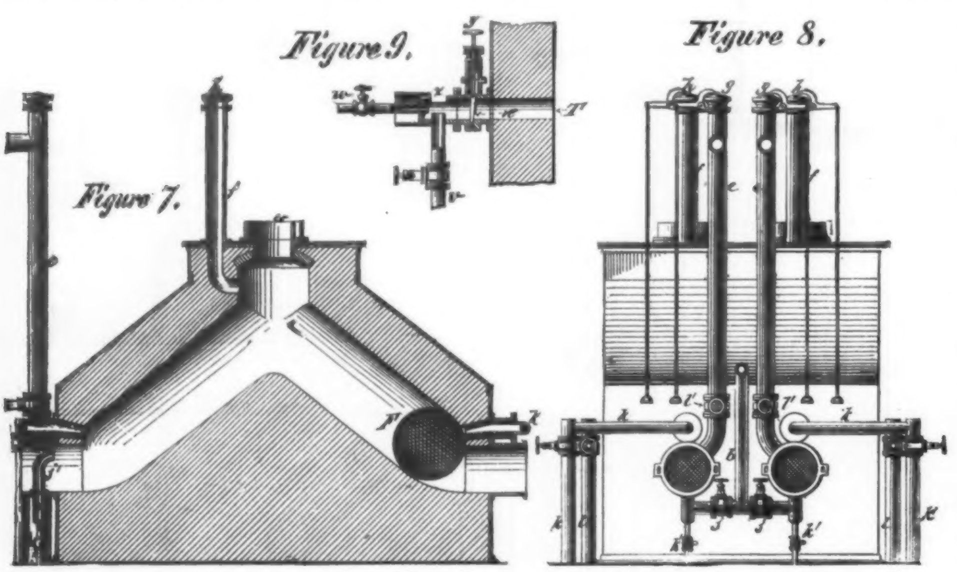
l represents a pipe communicating at the front and back ends of each chamber by suitable tuyeres connected with a supply of combustible gas containing a certain amount of hydrogen, as described. The pipe, *k*, supplies the air necessary for the combustion of the gas supplied by the pipe, *l*. As shown, the gas and air are introduced by means of a double concentric tuyere; but any other suitable way may be used. Pipes, *e*, are provided, which carry off the hydrogen gas to the holder, and they are also provided with purge-valves, *g*, for the purpose of thoroughly purging the apparatus before the production of the hydrogen gas. These pipes are also provided with suitable valves, *l'*, as shown, by means of which the hydrogen gas or the converted gas can be caused to flow in either direction.

The mixture of steam and naphtha vapor enters the ends of the chambers by means of pipes, *j*, Fig. 7, which pass somewhat above the bottom of the retort, as shown, so as to be above the lime, which would slide down the inclined plane. Cleansing-pipes, *k'*, are used for the purpose of removing any sediment.

In the process to be described it becomes necessary to kindle at times in the converting-furnace the gas and air which are there admitted by the tuyeres described. This can be done in any well-known way; but I have devised a little apparatus (shown in Fig. 9) by which it is readily accomplished. This apparatus consists of a tube, T, which communicates with the converting-furnace at some point near the supply point of gas and air, previously described. The pipe, *v*, is provided, which is supplied with a continuous current of gas, which is kept continually alight, and burns upward through the opening, *x*. The valve, *n'*, controlled by the rod, *y*, shuts off this flame from the interior of the furnace. When it is desired to light the same the pipe, *w*, connected with a supply of compressed air, is opened, when the flame, passing upward from the pipe, *v*, is blown inward through the tube, T, thereby lighting the gas previously supplied by the tuyere, *k*.

The operation of the apparatus can now be readily understood. It is first necessary to thoroughly heat one of the superheating chambers, C, and one of the converting-furnaces, E. These are made double, for the purposes already described. Gas produced in the generator, A, is introduced into the top of one of the superheaters, by the pipe, *m*, described. At the same time a sufficient supply of air is brought in contact with it by one of the branch pipes, *n*, provided with suitable valves, *m'*, one being open and the other closed. The purge-valve, *t*, is simultaneously opened, allowing the escape of the products of this combustion. At the same time a sufficient supply of gas and air is admitted by the pipes, *l* and *c*, to one of the chambers of one of the two furnaces, E; or, if necessary, a supply to both chambers, or a greater supply to one chamber than to the other, it being necessary that one of the chambers of the converting-furnace be hotter than the other. As soon as the superheater, C, has been sufficiently heated the supply of gas and air is shut off from it and allowed to enter the other superheater. At the same time superheated steam from the apparatus shown in Fig. 3 is caused to mingle with a sufficient amount of naphtha, and passed upward by pipe, *a*, through the superheater, where it becomes thoroughly heated without being converted. The combined vapors of water and naphtha thus highly heated are fed into the hot side of the converting furnace, E. Passing through this, they become converted into hydrogen and carbonic acid, which carbonic acid is not taken up by the lime on account of its heat, but passing through the opening, F', into the other branch or side of the furnace, E, it comes in contact with lime at a cooler temperature, and there the lime takes up the carbonic acid, forming carbonate of lime and leaving the hydrogen pure. Then the alternative action takes place. The naphtha and vapor are superheated in the other superheater, and are allowed to flow into the other converting-furnace. Meanwhile the mixture of gas and vapor described is burned with a sufficient supply of air in that one of the two chambers of the converting-furnace which had previously taken up the carbonic acid and contained carbonate of lime, whereby said carbonic acid is once more driven off, and the highly-heated lime remains ready to act upon the next supply of the vapors of steam and naphtha.

It may be necessary in heating the converting-furnace previous to the admission of the steam and naphtha to heat both chambers of the same, but to a different degree. This question of the relation of heats is a matter of experience, and can be easily determined by those acquainted with the business. It is very important, however, to have the two chambers heated to different temperatures, because the original decomposition has to take place in the presence of highly-heated lime; but the absorption of the carbonic acid takes place in the presence only of a cooler body of lime. It is plain, too, that these two masses of lime might be in separate chambers, if preferred.



TESSIE DU MOTAY'S NEW PROCESS AND APPARATUS FOR HYDROGEN GAS.

LINSEED OIL AND ELECTRIFIED OXYGEN.

As everybody knows, there are three classes of oils—1st, *volatile oils*, or those which dry by evaporation and leave nothing behind; 2d, *drying oils*, or those which dry by thickening and leave a film behind; 3d, those which do not dry at all, but remain greasy for an indefinite length of time. Turpentine may be taken as an example of the first. A simple way of distinguishing between the volatile oils and the fixed oils, to which latter class both the second and third of the above-named beiong, is to let fall a drop on a piece of white blotting-paper and leave it for a while. If the oil is volatile, and unmixed with any kind of fixed oil, it will all evaporate, and leave nothing behind. If a fixed oil, the spot at first produced remains unchanged. If a mixture, such as an impure volatile oil, then the spot becomes lighter, but does not entirely disappear; the volatile oil vanishes, but the fixed oil remains as a permanent spot, the density or body of the spot varying according to the proportion of fixed oil in the mixture. The nature of the spot, however, varies according to that of the fixed oil. If a non-drying oil, such as olive oil, lard oil, sperm, etc., the spot is greasy, and remains greasy; if a drying oil, the spot appears greasy at first, and is so to some extent, but it gradually changes from greasy to gummy, and from gummy to resinous, and finally dries as a spot of varnish instead of a spot of grease. Now, what is the cause of this change from greasy to gummy, and from gummy or semi-greasy to decidedly hard, dry, and resinous character? The uninitiated will probably answer that it "dries up," just as gum-water does when the water evaporates and leaves the gum, or as a varnish does when the spirit or volatile oil evaporates, and leaves behind the resin or gum resin that was dissolved in the spirit or volatile oil. This, however, is not the case, as may be proved by the simple experiment of saturating a quantity of blotting-paper, or painting a surface of common thin paper with good linseed oil, then weighing it in a delicate balance, and leaving it to dry. If the drying is due to evaporation, it must become lighter; but this will not be the case. It gains in weight rather than loses, and the finer the quality of the oil the more perceptible is the slight increase of weight, which in the best amounts to 6 or 8 per cent. What, then, is the nature of this drying, if it is so different from what we commonly call drying? This question has been answered by skillful chemical investigation, which has proved that the "drying oils" contain a liquid to which the name of *linoleine* or *linoxine* has been given, and that their quality as drying oils depends upon the proportion of this in their composition. This liquid when exposed freely to the air combines with oxygen, increases in weight thereby, and its properties change: instead of a greasy liquid it becomes a resinous solid. It is this solid that holds together the white lead or other powder that constitutes the body or coloring matter of ordinary oil paints. The necessity for such a binding material may easily be proved by mixing any dry color with turpentine alone and then using it as a paint. It will dry readily enough, but in this case it dries by mere evaporation, and leaves behind a dry powder which may be brushed away. Oxygen may exist in two different states—in a state of intense excitement, or in a state of ordinary activity. The excited oxygen is called ozone. The difference between ozone and ordinary oxygen may be compared to the difference between Mr. Gladstone at Midlothian and Mr. Gladstone in Downing Street. The most effective means of stimulating oxygen into a state of excitement, or of producing ozone, is by passing electric sparks through it. The electricity acts upon oxygen as a general election acts upon politicians. This ozone, or electrified oxygen, is far more energetic and vivacious in its combinations than ordinary oxygen. Thus silver may be exposed to ordinary oxygen without being oxidized, but ozone rapidly covers it with a film of oxide or rust. The same with other bodies with which ordinary oxygen sluggishly combines. A German chemist, Dr. E. Schrader, has applied ozone to linseed oil in order to start its oxidation, and has succeeded in bleaching and thickening the oil, converting it into a sort of varnish, which dries much more rapidly than ordinary raw linseed oil. He renders it similar to boiled linseed oil without applying heat, and with the advantage of bleaching instead of darkening it. The ozone acts at once, and the resinification may be carried to any desirable extent. If carried too far, it would, of course, destroy the fluidity of the oil, and thus render it useless for its purpose as a color medium. The ozonized oil may not only be used for this purpose, but also as the medium of printer's ink where a nearer approach to solidification is required. Many attempts have been made to supersede linseed oil by using natural resins, such as copal, mastic, etc., and dissolving them in spirits or volatile oils, then using the solution as a medium. The result is very promising at first. A painting made with a copal medium is very brilliant for a while, but presently the thick layer of copal begins to shrink, and then to crack, producing a network of ugly lines that are ruinous to anything like artistic work, or even to good house-painting. This seems to be the case with every kind of available resin except that produced by the oxidation of the linoxine. The film that is formed when linseed oil is oxidized is a peculiarly tough and elastic resinous substance, having none of the brittleness of ordinary resins or gum-resins. This may be shown by exposing some linseed oil in a shallow vessel to the air and light, and then examining the skin that forms upon it. Besides being remarkably tough, and pliable, and elastic, it is remarkably insoluble. The writer has tried every essential oil he could obtain, every kind of spirit, and chloroform, bi-sulphide of carbon, etc., without succeeding in moving it from the surface of some medallions which are damaged by it. This renders it especially valuable for painting, but as the oxidation or "drying" of ordinary oil is so slow, artificial forcing by the use of "driers" to combine with its fatty acid, or dilution with turpentine, or "boiling," or all three, are commonly used. The first two undoubtedly weaken the film. Whether this is the case with boiling we cannot say, but certainly any means of increasing the rapidity of the oxidation of the drying principle of linseed oil without altering its other properties is very desirable. We have no data upon which to estimate the cost of ozonizing linseed oil, which is, of course, important. If costly, it can only be applied to artists' medium; if cheap, every house-painter would welcome it, and the domestic victims of the house-painter still more eagerly than himself. We presume that there is no waste or loss of quantity in ozonizing the oil. This will be some advantage in the direction of economy over boiling, as well as the advantage of bleaching. At present this process appears to have only reached the scientific stage, and we, therefore, await its commercial development.—*London Grocer.*

DETECTION OF MERCURY.—Scarlet mercuric iodide appears perfectly white in the light of the sodium flame.—*H. v. Jüptner.*

DETERMINATION OF GLYCERIN IN WINES.

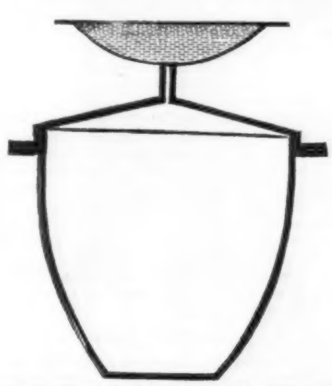
By M. RAYNAUD.

THE determination of glycerin is easily effected with exactness in pure wines, but the same process gives erroneous results in plastered wines containing potassium sulphate. The glycerin holds in solution potassium carbonate and extractive matter, even in presence of a mixture of ether and alcohol. The author, therefore, proceeds as follows: He evaporates the wine to one-fifth of its volume, adds hydro-fluosilicic acid, and then alcohol. The alkalies are thus thrown down, and the fluo-silicates may be collected if it is intended to determine the potassium and sodium. A slight excess of barium hydroxide is then added, and the whole is evaporated to dryness with a quantity of quartz sand. The residue is exhausted with a mixture of alcohol and ether, absolutely pure, the solution is slowly evaporated, and the residue is left for twenty-four hours in a dry vacuum over phosphoric anhydride. It is pure glycerin.

DETECTION OF MINUTE QUANTITIES OF MERCURY.

E. TEUBNER recommends for this purpose a modification of Eschka's gold cover test, which consists in causing the vapors arising from the dried and faintly ignited substance to impinge against the bottom of a gold capsule filled with water placed over an opening in the crucible lid. Teubner's modification consists in causing the vapors to come in contact only with a small portion of the bottom of the capsule. The apparatus has the form illustrated in the cut; the height of the crucible, as well as its upper diameter, is about 4 centimeters ($1\frac{3}{4}$ inches).

The finely powdered substance, dried as much as possible, is intimately mixed with well ignited iron filings and a little red lead, the mixture placed upon a layer of red lead in the crucible, covered with iron filings, the lid put on and luted with a paste made of lime. The crucible is now placed over the lamp and a gold capsule containing water, properly supported, placed over the orifice of the tube ascending from the lid. The heating must proceed very slowly and must



APPARATUS FOR DETECTING MERCURY.

only be gradually raised to a faint redness at the bottom of the crucible. Any little drops of water which may first collect at the orifice of the tube must be removed by filtering paper. The operation is finished in a few minutes, and any mercury present will be found deposited upon the exposed spot of the gold capsule. The identity of this deposit, if not too minute, may be established by bringing upon it a minimal drop of nitric acid, drying thoroughly on the water-bath, and then touching the spot with a strip of filtering paper moistened with a 1 per cent. solution of iodide of potassium. This causes the production of a characteristic red stain of mercuric iodide, disappearing again on applying an excess of iodide of potassium. If the diameter of the orifice of the tube be 1 millimeter ($\frac{1}{25}$ inch) so small a quantity as 0·0001 gm. ($= \frac{1}{648}$ grain) of mercury, and even less, may be recognized.—*Zeitsch. f. Anal. Chem.*

METALLIC VARNISH.

SOME years ago workmen at Natal observed that many of the *Euphorbiaceæ*, when cut by iron or steel, leave on the blade a coating of adhesive gum, which it is very difficult to remove, and which is an effectual safeguard against rust. The gum can be dissolved in alcohol and applied as a varnish to the hulls of vessels or other metallic surfaces. The alcohol soon evaporates, and leaves the gum in close adhesion. It is, moreover, so bitter that the white ants will not attack any object coated by it.—*Les Mondes.*

ARTIFICIAL WINES.

THE ravages of the *phylloxera* have greatly increased the demand for "artificial wines" and brandies, or those made from raisins. E. Martin undertakes the defense of these products, and says that chemical analysis can show no difference between them and those made from fresh grapes. He states, however, that it is better to add an equal portion of fresh grapes, so as to quicken the fermentation which has been rendered sluggish by drying. When this is done, he defies the most skillful connoisseur to detect two specimens of artificial wines among eight others of natural wines.—*Chron. Indust.*

THEORY IN REGARD TO EARTHQUAKES.

AN interesting article by M. Heim, in a recent number of *La Nature*, calls attention to the fact that earthquakes occur most frequently at the period of spring tide and at perigee. In reference to this, a correspondent of the above named journal says: "It is just exactly at these epochs that tides are strongest. Now, among the objections formerly made to the partisans of the theory of the earth's fluidity, at the center, was the one that, if such a liquid mass does exist, it ought to be subject to the attraction of the sun and moon, and in its movements it ought to elevate the earth's crust. Since the frequency of earthquakes, at the epochs indicated, coincide with the greatest tides, is it not really the effect of that cause? May we not find therein one of the multiple causes of earthquakes, and at the same time refute the objection offered, I believe, by Sir Humphry Davy? I know not whether this idea has already been put forth, but, such as it is, I believe it merits examination."

THE CHINESE IN CALIFORNIA.

IT would be hardly just to dismiss the subject of hard times and business depression on the Pacific coast without some reference to the Chinese, whose presence here is firmly regarded by a large part of the community as the true cause of all the troubles that have come upon California during the past few years. The Chinese question, notwithstanding all that has been written and said about it, is still, it must be confessed, a hard and many-sided problem even to the unprejudiced who have an opportunity of witnessing the results of Chinese cheap labor on the Pacific coast.

The subject is a difficult one, because it is as impossible for the most casual observer to overlook the injuries which the presence of thousands of Chinamen cause to the people of the Pacific slope as it would be to deny the immense services which they have rendered in developing the country.

CHINESE IMMIGRATION.

Chinese immigration began very soon after the gold fever of 1849. It was of no especial account, however, until the year 1852, when over 20,000 Chinamen came to the coast. Since the latter date the arrivals have annually numbered several thousand. There has also been a large number of departures in each year, but in no instance has the number of those returning to the flowery kingdom equaled that of the arrivals. The total number now in the State may be safely estimated at 150,000, or more than one-sixth of the entire population. San Francisco claims a population of 300,000, and it is safe to say that of that number 50,000 are Chinese.

From these figures it will be seen what an element for good or evil the latter form in the community. In almost every capacity they find employment, and the secret of their success, whatever their trade or calling, lies in their extraordinary habits of economy, frugality, and industry. These traits, which are almost universal among them, are not virtues so much as necessities with them.

When it is remembered that for centuries food has been so scarce in the over-crowded Chinese Empire that hundreds of thousands annually die of starvation, while the existence of the cooly class is always merely a struggle to obtain rice enough to support life, it will not seem so strange that the modern Chinese laborer comes to the United States with habits of ceaseless industry and rigid frugality which in labor give him an immense advantage over the average white man, who when forced to earn his living by the sweat of his brow does so almost under protest. The Chinaman considers himself fortunate if he has a chance to work ten, twelve, or even more hours per day for from fifty cents to a dollar. The white man places the limit at eight hours, and is not content with treble the wages of the Chinaman.

Of the Chinese in San Francisco some six thousand are engaged in cigar making. Probably as many more are employed in the manufacture of shirts and underclothing. The boot and shoe factories give employment to about three thousand. In these trades they receive from forty cents to one dollar per day. The other trades give employment to about eight thousand more at the same rates of wages.

THE MISTAKE OF THE KEARNEYITES.

The grand mistake which lies at the bottom of the anti-cooly movement of a half a dozen years ago, and also of the workingmen's agitation to-day, is the popular idea among white laborers and mechanics on the coast that if they could only get rid of their Chinese competitors, the expulsion of the latter would be promptly followed by the employment of from 100,000 to 150,000 white men in their places. The truth is, however, that this popular impression is a grand delusion. In San Francisco and throughout the State white men in the trades receive from two to three and a half dollars per day. But very few are employed at such rates, at least in the trades in which Chinamen can be engaged, for there are few manufacturers who can afford to pay such high wages, and certainly one result of the departure of the Chinese would be the closing up of many manufactories.

The ignorant and unemployed who clamor for the expulsion of the Chinese appear to lose sight entirely of the fact that employers who with cheap labor have often no margin for profit would be compelled to close down if forced to pay white men's wages. The departure of the Chinese would doubtless be followed by the substitution of white labor to some extent, but it is a question whether this result would compensate for the widespread evils that would attend the sudden withdrawal of the former.

A PARADOX IN LABOR.

While the great mass of the people here believe the presence of coolies to be the greatest evil to the white laboring classes, there are not wanting thoughtful men who realize the mischief that would be caused to many industries by the sudden withdrawal of cheap labor.

The course pursued by white laborers, mechanics, and artisans on this coast has always been in the nature of an economical paradox. As an old Californian informed your correspondent a few days ago, there has seldom been a time since the days of '49 when the streets of San Francisco were not crowded with unemployed white men of every trade and calling. Singularly enough, however, this over-supply of labor has not, generally speaking, been accompanied by a proportionate decrease in wages. While hundreds of men were idle, many being skilled mechanics, those who could find work at their trades have usually received wages proportionally higher than the amounts paid to mechanics in the East in times when labor of this kind was none too plenty.

This anomalous feature of the labor problem has prevailed on the coast from the early days, and continues now unchanged so far as many trades are concerned. Still more singular, however, is the fact, that notwithstanding all the clamor about the Chinese, the presence of the latter has not in any marked degree lowered the wages paid for white labor.

It has rendered it a more difficult task for mechanics to find employment, but the lines of distinction between a Chinaman's wages and those of a white man, in the trades, have always been sharply defined and widely separated. In other words, the mere fact that a mechanic is of Caucasian blood is, with some employers, sufficient reason for paying him double or treble the wages of the mechanic of Mongolian blood even though the latter does the same work as the former and as well. Of course this singular state of affairs will not be found in every factory or workshop, but it exists wherever both races are employed together.

It is also a significant fact for those who agitate the Chinese question on the grounds of labor that in certain trades in which Chinamen have never engaged there are probably almost as many unemployed white men as in the trades in which Chinese labor is in demand. For example,

foundrymen, boilermakers, bricklayers, ship builders, carpenters, cabinetmakers, are all white men. The Chinese rarely engage in any trade in which great physical strength is necessary, and besides, they have not the necessary training. Yet in all these trades there is the same over-supply of labor that there is in those in which the Chinese compete, and also the same high rates of wages. The natural query then is, Why should the lack of employment for white men at high wages in trades followed by Chinese be attributed to the latter, when there is about the same number of unemployed men in the trades to which Chinamen as yet have no access?

A CHANCE FOR WORKING GIRLS.

A great deal is heard about the injury which the presence of the Chinese causes to young men and women who have to work for a living. This is always made an especial argument with those who look at the question from the labor point of view. The truth is that cooly labor here is much less an obstacle to the young women than it is to the young men. The rising generation of California is peculiar.

Our boys and girls as a rule are strong and healthy, but it must be confessed that they are not overfond of toil, and it is a noticeable fact that many of them seem rather satisfied to remain idle so long as they can attribute their idleness to their being crowded out by Chinese. There is, however. one method by which every working girl in the State can earn her living, and that is by going out into service. There has always been a demand here for white girls and women as servants in private families, and the demand for this kind of labor is much greater now than the supply.

To be sure, there are over 6,000 Chinamen employed as house servants in San Francisco, but their presence is no obstacle to any white girl who wishes a place. The scale of wages, too, between white and Chinese labor is quite as sharply defined here as in the other callings in which the two classes are engaged. Chinese servants receive from $12 to $20 per month. White servants have from $15 to $40 per month, and are scarce at that. A good white cook often receives $40 a month, while girls of fourteen or fifteen years receive from $10 to $15 for taking care of children and doing light housework. White girls here as servants receive wages that would make their Eastern sisters envious. Singularly enough, however, California girls have generally very strong objections to earning their livings in this way.

THE CHINESE AS SERVANTS.

The general employment of Chinamen as house servants is due rather to the scarcity of good white servants than to any preference for cheaper "help." While the industry and carefulness which John so generally exhibits are not quite as noticeable when he follows this calling as they are in some others, it cannot be denied that as a servant he is immensely superior to the average Irish girl. He has no "cousins" to distract him from his duties, or if he has any he entertains them in the dark purlieus of Chinatown and in a manner only known to himself. He does his work carefully and promptly. In person and dress he is scrupulously neat and clean. He is always polite, but never servile: John never loses his self respect under any circumstances.

Chinese servants ordinarily sleep in the houses where they are employed. Occasionally they take advantage of their position, as white servants sometimes do, to let in by night some of their countrymen of burglarious propensities, but as a rule most families prefer to take the risk and allow their Chinese help to sleep in the house. They are thoroughly cleanly about their persons, but when allowed to sleep in Chinatown they invariably perfume the house on the following day with that disagreeable, smoky, greasy smell which pervades every Chinese dwelling, and which is mainly due to the Celestials' fondness for bad pork and their aversion to using a chimney for their fires, the smoke being allowed to escape through the windows and doors. The Chinese servant expects to go out about every evening in the week, but he is prompt to return at the time fixed. With all his good traits as a servant, John is more objectionable in that capacity to most families than in any other, and very many people who employ the heathen would be glad to substitute for him an indifferent Irish, Swede, or German girl. It is never safe to leave a Chinese servant in charge of young children, for he is innocent of anything like decency or morality. It is not well either on discharging him to give the month's notice usual on getting rid of a white servant.

The custom on dismissing a Chinese servant is to give him no warning whatever, but to watch him closely while he packs up his traps. Otherwise he may be tempted to carry off what portable property he can lay hands on, or to cover the walls with hieroglyphics which may mean imprecations on the family, but are shrewdly supposed to convey information for the benefit of future Chinese comers as to the whereabouts of the family plate.

John's superiority as a servant consists simply in the fact that he does his work well. In nothing else can he be trusted. His tendency towards petit larceny is usually restrained by a fear of detection. There are some temptations, however, which nothing will enable him to withstand, and chief of these is a clock. Why a Chinaman will always steal a clock is a dark mystery, but certain it is that any kind of a clock is a temptation of the strongest kind, while a round clock of the alarm variety is absolutely irresistible to him. To possess the latter he will often give up his place and decamp by night, while the absence of the timepiece will be the first intimation that the family will receive in the morning that they are without a servant.

CHINESE ENTERPRISE.

A fair example of what a Chinaman's industry and economy will accomplish can be seen in the success with which he raises and sells fruits and vegetables in this city. An American desiring to go into this kind of business would begin by buying or leasing a small ranch, as convenient to the city as possible. He would employ white men, at white men's wages, to cultivate it. He would have to ship his produce to market, and after paying all charges he would find the smallest possible margin for profit, if indeed he found any at all.

Now see the way the Chinaman does it. His "ranch" will comprise a few acres of seemingly worthless land on the outskirts of the city. Very likely it will be two or three vacant lots from which earth has been excavated until they lie far below the grade of the adjoining streets. They are worthless for the present at least and rent for anything. In this cellar, as the place might almost be called, John will establish his "ranch." First, he will build him a rough cabin, constructed of whatever odds and ends of boards he can pick up, large enough for himself and perhaps some shrill-voiced old crone of his own race whom he has purchased for a few dollars to be his wife and servant, but especially to aid him in the latter capacity, looking after his interests generally. Then another rude cabin will be built for the three or four Chinamen whom he will employ, at Chinamen's wages, not to carry on the proposed ranch, but to work on it as hard as he does himself, which means from sunrise until dark.

It is astonishing what those Chinamen will accomplish on such a "ranch" as the one described. Still it is a fact that a very large part, probably a half, of the vegetables consumed in San Francisco are raised by Chinamen on just such places as the one described. Some of these gardens are conducted by only two or three Chinamen who work them in partnership. The cost of raising the produce of course is far less than that on the American's ranch, but it is in bringing his wares to market and selling them that John makes his saving. He pays neither freight nor commission. His garden is close by his market, and the latter is the nearest part of the city where there are residences. Early in the morning he goes forth to be his own huckster. The white huckster, of course, must have his horse and wagon, but the Chinese dispense with both and save the expense. They carry their stuff to market, and take it directly to their customers.

Every morning these fruit and vegetable venders may be seen staggering through the streets under their heavy burdens. The Chinese huckster's outfit consists of two large baskets, holding perhaps a bushel and a half apiece, and a stout bamboo pole. The baskets are attached to either end of the pole, which the Chinaman places across his shoulder. His stock of eatables is quite as varied and almost as bulky as that in an ordinary huckster's wagon. In one basket will be melons and the fruits of the season, in the other cabbages, squashes, and a variety of smaller vegetables. He will sell five cents' worth of almost everything his baskets contain, and the large measure he gives for a half dime would be astonishing were it not for the fact that he practices the same economy in vending his wares as in producing them.

His margin for profit, too, is not infrequently reduced by the depredation of his purchasers' children, who make raids on his baskets while he is engaged with the housewife in the regular haggle that always precedes every transaction, great or small, with a Chinese peddler. As the morning advances and the contents of John's basket become lighter with many sales the stoop in his shoulders grows less, and by noon he trudges back to his garden, erect and happy, keeping carefully in the middle of the street, however, for there is a "basket ordinance" as well as a "cubic air ordinance," and John is fined if he seeks to save his stockings by leaving the muddy street for the sidewalk.

It may seem odd to an Eastern reader that a Chinese vegetable peddler should mind a little mud on his hose, but it is a peculiarity of this most peculiar people that, whatever their calling or circumstance, they are as fastidious about their white stockings as a dandy is about his shirt front.

Of course the extent of the Chinese huckster's transactions is small compared with those of white men raising vegetables outside the city, but the former never fail to accumulate enough to return to China—the grand aim of their lives—in comfortable circumstances, while the latter find that high freights and commissions leave them but little profit from their more pretentious farms.

NEGLECTED LABOR.

There is one remarkable feature of the Chinese problem that seldom escapes the Eastern visitor's attention. This is that the presence of an abundance of cheap labor seems to have done almost nothing toward building up manufactures in California. Considering the great difficulty which California manufacturers have ever experienced in obtaining white labor at anything like the low rates of the East, it seems surprising that so little has been done toward utilizing the Chinese, who are capable of mastering almost any mechanical acquirement, and could be employed by the thousand. Comparatively little has been done in this direction as yet, however, with the exception of the trades mentioned. But California manufacturers for some reason seem to have no success, whether they employ Chinamen or whites. For instance, from one-half to two-thirds of the boots and shoes sold annually in the State are imported. California annually sends to the East $1,000,000 worth of leather, which Eastern manufacturers, employing white labor, convert into boots and shoes. They send it back to this State and sell it cheaper than the home manufacturers can vend their product made up by Chinamen and from leather produced here. In other branches of manufacture very much the same results are observed. We have the Chinese. They keep our people in a perpetual turmoil, but comparatively little is done to turn the evil of their presence to profit, as could be done in employing them in manufactures.

THE CHINESE IN THE COUNTRY.

It should be borne in mind that the Chinese labor problem, though mainly agitated in San Francisco, is by no means confined to this city. Most of the large wheat ranches in the valleys of the Sacramento and San Joaquin rivers are carried on with Chinese laborers. Farmers as a rule prefer Chinamen, and for a variety of reasons. First and foremost of these is the fact that the Chinaman does his work, and that for every four or five employed it is not necessary, as it often is with white laborers, to have an overseer to keep them from shirking.

The Chinese farm hand, too, is less fastidious about his board and housing than a white man frequently is. The Chinaman has not the least desire to sit at the farmer's table, and the barn is as good a sleeping place as he cares for; in fact during the dry summer months, while the harvesting is going on, he has no objection to sleeping in the open air on the ground.

Hydraulic mining also gives employment to a great number of Chinamen. The mountains are full of them, and more than one miniature Chinatown, possessed of all the smells and most of the iniquity of that in San Francisco, can be found among the peaks of the Sierras. Some of the Chinese miners, most of them in fact, are employed by white men in working the gravel beds, but it is a favorite enterprise with many of them to take some worn out claim, deserted by white men, and wash the earth for the gold that has escaped the first washing. In this way they often make a very good thing. In the quicksilver mines Chinamen are very generally employed. The work is dangerous and so injurious to health that few white men care to engage in it.

One might suppose that the most ardent Kearneyite would have no objection to the Chinamen's working in such places as the noxious quicksilver mines. But when the law of the last legislature, prohibiting the employment of Chinese by corporations, went into effect, the very first prosecution brought under it was against the officers of a quicksilver mine. As the absurd law was promptly declared unconstitutional by the United States Circuit Court—which tribunal, by the way, unlike some of the State courts, has shown little sympathy with laws designed to oppress the Chinese—the quicksilver mines are still mainly worked by Chinese miners.

The Chinese have played an important part in the construction of railroads on the coast, and if their cheap labor could be utilized so that more railways could be constructed and the country opened up, they would render us a service that would do much to compensate for the trouble which their presence has already caused us.

The Southern Pacific Railroad, which is now being pushed so rapidly through Arizona, is being constructed almost entirely by Chinese labor. It is not easy to find good white laborers, even here where so many are unemployed, that are willing to go down to the burning desert and perform the hard work of track laying.

JOHN'S TAXES AND TREATMENT.

While the Chinese have helped to build our railroads, open up our mineral resources, and develop our wealth, they contribute but little to the revenue of the State. The assessed value of all the taxable property in the State is in the neighborhood of $500,000,000, but the Chinese, who, as has been said, form over one-sixth of the population, pay taxes on only about $1,500,000.

In fact John has the strongest objection to taxes of every description. Poll tax is an abomination to him, and his efforts to avoid it are as remarkable as the devices of the assessor's deputies to make him pony up.

He may escape the vigilance of the latter for a time, but he usually has to pay in the end. Even if he contemplates a return to his native land, where poll tax is unknown, he will find the vigilant deputy assessor on the wharf, and each Chinaman before boarding one of the Pacific Mail steamers to return to China is compelled to show his poll tax receipt—not, of course, by law, but by the same spirit of compulsion by which he is made to ride in the smoking car on a railway or turn out on the street to allow a white man to pass.

In fact the feeling among Californians is too often prevalent that a Chinaman is utterly without the pale of law as well as of courtesy. Instances have often occurred where Chinamen afflicted with leprosy or other loathsome diseases have been kidnaped and forcibly shipped back to China at the instance of city officials. These acts were not done as sanitary measures, but simply to save the city expense.

There are always from one to twenty lepers in the Chinese quarter, and a hospital is provided for those very much diseased. Leprosy is well understood here to be not easily contagious—at least such is the opinion of physicians as regards the cases here, and there is not an instance on record of any white man ever having taken the disease in this city. Still it has been the custom with our city fathers to periodically cause the kidnaping of all known lepers, who are forthwith carried down to the Pacific Mail steamer and shipped for China. The kidnaping, of course, is arranged to take place just before the vessel sails, and is usually successful, although occasionally the general effect is marred by the appearance of a sheriff with writs of *habeas corpus* for the captives.

THE SENTIMENT IN CALIFORNIA.

Californians as a rule have little patience with the views of Eastern people on the Chinese problem. They forget that the agitation on the question springs almost entirely from the laboring classes, whose objections to the Chinese are founded almost wholly on the grounds of labor.

The intelligent Californian understands quite as clearly as the Eastern thinker that opposition to the Chinese, because they can and do work cheaper than white men, is as absurd and illogical as it would be for the Eastern mechanic to inaugurate a crusade against the introduction of machinery and labor-saving appliances in an Eastern factory. The true objection to the presence of Chinamen is not that they can work cheaper and live cheaper than white men. The real injury that they do is that they convert a part of our State into China.

The Chinaman cares nothing for our government or institutions. He pays the closest attention and learns all that relates to mechanical arts, but in all other respects he regards himself as immeasurably our superior. He is here merely to earn what he can and then leave us. His ambition is not high, four or five hundred dollars will satisfy him. When he has accumulated that amount he can go back to China, purchase two or three wives, and live on the interest of his money in Celestial bliss for the rest of his days.—*Boston Commercial Bulletin.*

FISHING BOATS AT THE BERLIN INTERNATIONAL FISHERIES EXHIBITION.

FISHING and sailing are naturally very closely connected, and we find that fishing nations always produce the best seamen, for they are accustomed to the dangers and hardships of the ocean from the very days of their youth. There are hundreds of boats and models, and drawings of the same on exhibition at the Berlin International Fisheries Exhibition, but it is evident that it is impossible to go into a detailed description of all of them, and it will suffice to explain a few characteristic specimens, especially as all vessels, from the hollow trunk of a tree to the vessel of the most perfect construction, have a certain typical form, which evidently follows a law of nature.

As the annual yield of the Norwegian fisheries amounts to about $6,000,000, and gives employment to about 95,000 persons, the Drontheim fishing boat, shown as No. 1 of the annexed cut, taken from the *Leipziger Illustrirte Zeitung*, is deserving of some attention. The boat is about 50 feet long, 13 broad, and 7 feet deep, of 50 tons burden, and has a crew of six men. The fishers catch mackerel, herring, codfish, etc., and transport them to the southern points of Norway (Stavanger, Christiansand, etc.), a trip which is by no means devoid of dangers.

In regard to seaworthy qualities the English fishing boat, No. 2, is in all respects equal to the Drontheim boat.

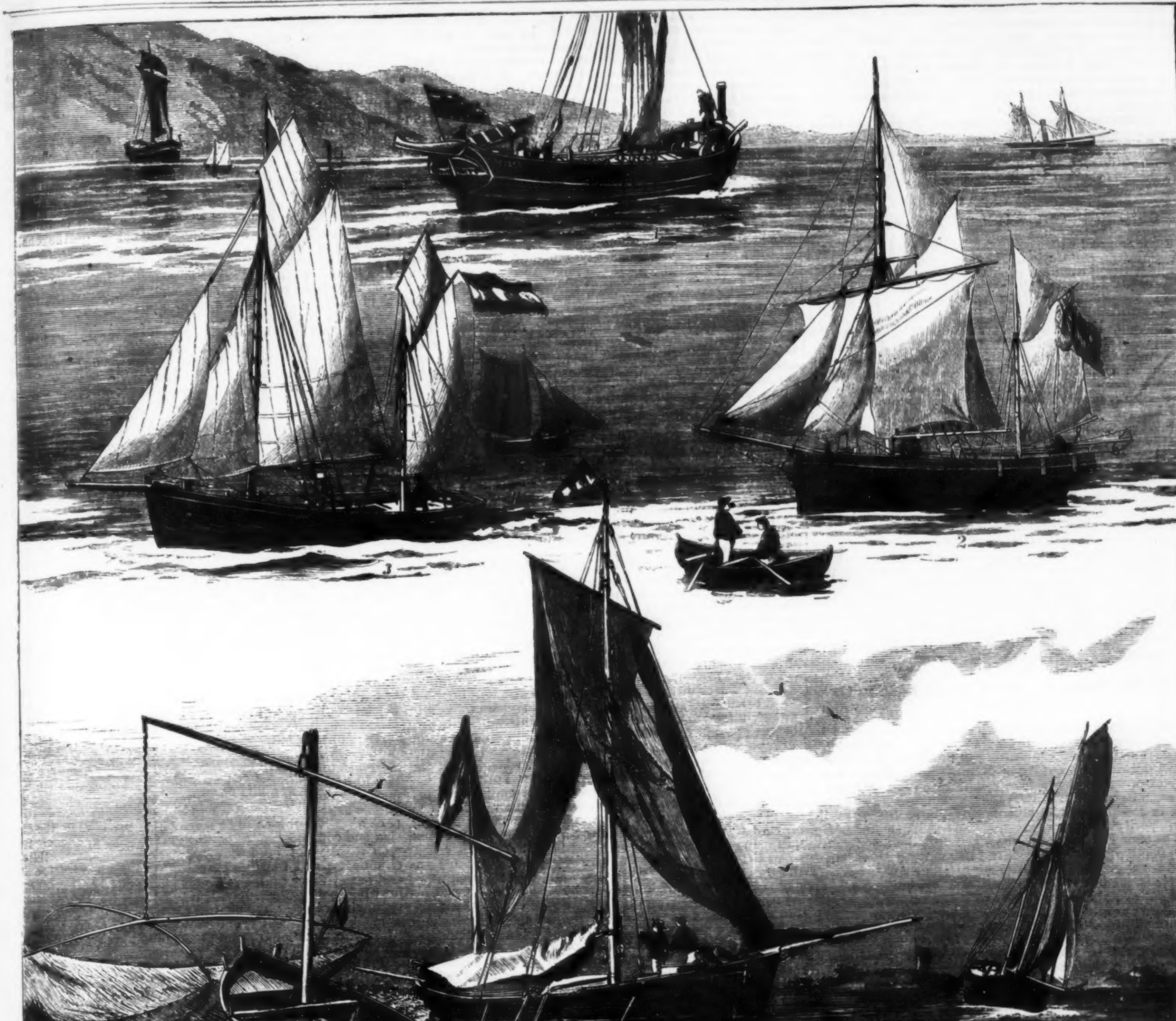
No. 3 represents a fishing cutter constructed by E. Kühl, in Blankenese, near Hamburg. It is 55 feet long, 19 feet wide, 6 feet 8 inches deep, of a very solid construction, and its elegant lines elicited general praise.

No. 4 is a Norwegian pilot boat, which is also used to catch mackerel, and is of a very solid construction.

No. 5 is a herring boat, of from 65 to 80 feet in length, constructed by C. Danziger, in Emden (Germany). A ground net is used, and only five men are required to man the boat, whereas other herring boats require from twelve to fifteen.

Shipbuilder Peus, in Stralsund, exhibits the ocean fishing boat, No. 7, in original. Most all fishing boats are provided with a perforated box in which the fish can be kept alive, and the Stralsund boat has this box arranged at the rear, which affords several advantages above the old arrangement.

The boat No. 6 is provided with a net suspended from one end of a lever, by means of which the net can be lowered



1. Drontheim Fishing Boat. 2. English Fishing Boat. 3. Fishing Cutter, constructed by E. Kuhl in Blankenese. 4. Norwegian Pilot Boat. 5. Herring Boat, constructed by C. Danziger in Emden. 6. Tilting Net Boat of Consland. 7. Ocean Fishing Boat, constructed by Pens in Stralsund. 8. Shadow Canoe. 9. Fishing Boats of Netherland-India.

FISHING BOATS AT THE BERLIN INTERNATIONAL FISHERIES EXHIBITION.

and then raised after a short time. This boat is principally used in the rivers of Courland in Russia.

No. 8 represents the shadow canoe, the delight of all sporting clubs. It is provided with sails, and can be used for pleasure trips, hunting, and fishing, and can carry one person and a certain quantity of food and water, but as it weighs but one hundred pounds, not too much must be expected of it.

No. 9 represents the fishing boats of Netherland-India. The sails are made of bast matting, and the outriggers serve to balance the ship and prevent careening, for in a heavy gale one of the men gets upon the outrigger on the windward side and thereby steadies the boat.

COFFEE PRODUCTION OF THE WORLD.

The four great coffee countries of the world are Brazil, Java, Sumatra, and Ceylon. The data and figures for 1879 show that Brazil itself has produced an extraordinary quantity of beans. Hitherto 250,000 tons have been considered as a good yearly figure for Brazil; last year the export alone amounted to 273,000 tons. But the consumption of coffee in the country itself now amounts to 60,000 tons, raising the total yearly products of Brazil to 333,600 tons. Fortunately for the planters in other parts of the world, coffee has grown into a necessity in the United States, and, thanks to this, its price has risen. Although the soil of Brazil, especially for coffee culture, is very extensive, yet the difficulty of obtaining labor daily becomes greater, and this renders it doubtful whether the above figures can be much exceeded. The crop in Java and Sumatra was estimated at 94,000 tons for export; the consumption of the inhabitants, although the population is double that of Brazil, is not half of that of the latter country. The production in Ceylon, though greater than that of 1878, shows a falling off when compared with former years; there were in all 41,200 tons exported from the island, the native consumption being very small. Coffee is besides grown in Central America, in several of the South American republics, in the British and other colonies of the West Indies, in Hayti, Cuba, Porto Rico, Arabia, Mauritius, Réunion, and along the north-east coast of Africa, in Liberia and the African west coast, in Manila, Celebes, and several of the islands of the Pacific, and, lastly, in British India. But the total production of all these regions does not reach half of the export of the four chief countries named above.

THE DISCOMFORTS OF SUMMER RAILROAD TRAVEL.

A very sagacious writer, who has often been quoted in these columns, has imputed to a "statesman" the following recommendation for the improvement of the administration of railroads: "Look out," he says, "for a very ingenious, sickly man, with a large family, and give him $20,000 a year as an inspector of railways. Let him make short reports, in good English, of his sufferings on the different railways; specifying names, dates, and every particular. He must be bound to travel, occasionally, with his whole family, in the depth of winter. It is true we know all about these sufferings at present, but not sufficiently in detail."

There is, no doubt, a special class of discomforts which attend railroad travel in winter, but it is not of these that it is proposed to speak now. The imaginary inspector should be required to travel in midsummer as well as in midwinter. Although there is no reason to expect that the "statesman's" suggestion will be adopted, yet what would seem to be quite a practicable measure would be the selection of intelligent persons by the managers of railroads, to travel over their lines, unknown to the subordinate officers, and make such reports as are proposed above. Probably the manager would hear of the existence of a good many abuses and evils, of which otherwise he would remain in ignorance.

It would not be difficult, though, for any one who has traveled much in summer, even without the qualifications enumerated, to suggest various improvements and to point out some of what appear to be remediable discomforts which attend travel in summer.

There is, of course, first, and perhaps greatest of all, the heat. Then there is, secondly, the dust and cinders, and third, the first and second combined; all of which will be discussed in their order.

With reference to the heat, it would seem as if something could be done to diminish the effect of the sun's rays on the roofs of cars. As they are constructed at present they consist of rafters, or purlines, on top of which thin boards are laid, and these are usually covered with tin, painted some dark color. To the underside of the rafters, on the inside of the car, the head-lining is nailed. Latterly, in some of the better class of cars, what are called ceiling veneers are used instead of head-lining. In either case, there is a space of only a few inches in depth between the two. The consequence is that the rays of the sun "beat down" on the dark-colored tin roof, which thus becomes very much heated, and as there is little to intercept the heat it is communicated to the inside of the car. The effect is very much like that which occurs in rooms located directly under the roof of a house. On one occasion the writer was compelled to occupy as a drawing room an upper apartment with a low ceiling directly under a tin or slate roof. In summer it was so hot that only profane adjectives would adequately describe it. Fortunately for the draughtsmen one of the proprietors of the establishment was obliged to occupy the same room for a considerable portion of the day. In order to reduce its temperature he therefore had a covering of rough boards placed two or three feet above the roof so as to keep the rays of the sun away from the latter. The space between the two was left open so that there could be a free circulation of air through it. The effect of this was, that from being one of the hottest rooms about the place, it became one of the coolest. For cars some similar arrangement seems possible. That is, a space—of course less than two or three feet—could be left between the outer roof and the ceiling, and provision could be made to produce a circulation of air through it by the motion of the car. Openings could be made in the ceiling to communicate with this space, and if it was connected with an aperture at the end of the car, over the platform and under the extended roof, the rarefaction of the air at the back end, due to the motion of the train, would produce very effective exhaust ventilation from the ceiling.

With this arrangement it would be necessary always to close the front opening and have the rear one open. This could be done by a flap valve of India-rubber, leather, or canvas, hung so as to swing outward and cover a grate or wire screen in the opening. The inward pressure in front would keep the valve at that end closed, and the one at the back end would be opened by the outward pressure. The details any intelligent car-builder could work out. The effect of such an arrangement would be very much the same as was that of the covering of the roof of the office referred to.

But it may be said that the heat of summer travel is much more tolerable than the dust and cinders. It is these latter, combined with the perspiration induced by the heat, which gradually covers the exposed skin of the unhappy passenger with a sort of viscid paste, which makes a negative answer to the question, "Is life worth living?" quite foregone. Now what can be done about dust? Of course, for its prevention, or its very material diminution, there is but one sure and obvious means, and that is stone ballast. But this is not always permissible on account of cost, and may be for other reasons. Twenty or twenty-five years ago there was a vast host of inventions and devices for excluding dust by sifting and filtering the air, and cars were built which required a man to be a hydraulic engineer to manage properly. Of these devices it may be said generally, that they have passed away as utterly as the seventeen-year locusts do, although a crop of these insects and of that class of inventions reappears at similar intervals. Generally, though, it is may be said that little or no relief from the evil of dust is to be expected from devices of this kind. The results which they accomplish are not worth the trouble and expense involved. In other words, they cost more than they come to. On very dusty roads the only practicable means of mitigating the evil seem to be, first, the admission of air from some point where the least amount of dust will enter; second, provision for excluding it when the windows are open; and, third, adequate facilities for ablution in the car.

With reference to the first it may be said that it involves the whole question, or at least all the difficulty that there is in ventilating cars. It is curious, too, how singularly the essential point about car ventilation has been misapprehended. The efforts of inventors and car-builders have been directed chiefly to providing means of allowing the air to escape from cars, about which there is no difficulty, and have generally neglected to provide means for its admission.

Of the latter, it may be said that the place in a railroad car which is freest from both dust from the roadbed, and cinders and smoke from the locomotive, is at the frieze, that is, on the sides just below the eaves of the roof and at the corresponding position at the ends, but under the projecting roof above the platform. Of course the higher up the opening the less liability there is of encountering the dust from the roadbed, but the roof is exposed to the smoke and cinders from the locomotive. Therefore the frieze is the point where there is least dust and is also but little exposed to smoke. At the end of the car the frieze is also protected from the latter by the projecting roof. Besides this, an opening for the admission of air at this point has the advantage, if it is in the front end, that the motion of the car produces an induced inward current, which is not the case on the sides. Mr. Creamer, of New York, who has been the great advocate of the plan of placing the supply openings on the sides, uses powerful exhaust ventilators in the clear-story. These, as it were, suck the air into the car through the supply openings in the frieze. The arrangement for the admission of air at the end of the car, however, seems to be preferable to this, for the reasons which have already been stated. It is essential, though, that they should be placed as high up as possible, so as to be far from the dust which rises from the road, and of course the closer they are to the under side of the projecting roof the more will the latter protect the openings from smoke and cinders.

It makes very little difference, though, how the openings for the admission of air are arranged, if the dust enters the cars through open windows. Considering the comfort which results from the use of dust deflectors, it is astonishing that they have not come into more general use. These, as most travelers on railroads in this country know, consist simply of a board placed vertically under the window sash, when it is up, and on the front side of the window opening. It projects out at right angles from the side of the car, and the effect is to produce an outward current of air from the window. It also deflects the cinders, and thus, in a great measure excludes both from the car when the window is open. These deflectors are seldom found anywhere excepting on sleeping and drawing-room cars, and not always there, and are generally of a portable and temporary character. It would seem as if there was a very good opportunity for some ingenious inventor to devise an arrangement of this kind which would be permanently attached to the car, and which could be folded either inward or outward when the window was closed.

The Committee on the Prevention of Smoke, in their report to the Master Mechanics' Association at the late meeting, recommended "locomotive boilers of the largest possible capacity; careful firing and the admission of air above the fire," as the most practicable means known for diminishing smoke. There may be others which are equally or more available, but they are not now definitely known to be so.

At best, then, the evils complained of can only be mitigated. On a dusty road there will be dust, and for the present, at least, the science and art of mechanical engineering have not provided any practicable means of entirely preventing smoke and cinders. This being the case, and as the evil cannot be prevented, the next thing to do is to provide a specific. Happily there is one which is obtainable anywhere, at little or no cost, and it can be taken as often as desirable without injurious effects. We refer to cold water. In other words, adequate provision for frequent ablution is, perhaps, the best remedy for the evil referred to that is known. In sleeping and drawing-room cars this is always provided, but it would seem as though it could be supplied at so little cost that it should be found on all first-class passenger cars.

The discomfort of car seats is a subject complained of not only in warm weather, but is much greater then, on account of the heating effect of personal contact with red plush, with which such seats are usually covered. The agreeable sensation which one enjoys in warm weather in occupying the cane or rattan seats of the New York Elevated railroads suggests their general adoption on all roads in summer. The use of such seats is universal in tropical countries. Why would it not be possible to devise a seat the cushion and back of which would be removable in summer, and which could be replaced by some kind of cane fabric?

Another evil with car seats is, that they are always made too narrow. They are seldom more than fifteen or sixteen inches wide, measured from the front to the back. To be comfortable they should be at least eighteen or twenty. It is singular, too, how some errors acquire general acceptance. Among them is the prevailing one among upholsterers that a seat should be made convex in form. The delusion is apparently a modern one, and came in with upholstered furniture. Our grandfathers knew much better when they smoked their pipes at ease in their old leather and splint bottom chairs. In the old stage coaches, too, the seats were inclined backward, so that there was little trouble in remaining in them, even on a rough road. The Pullman Car Company in building the cars for the Metropolitan Elevated road in New York, recognized the comfort of this old arrangement, and the seats have all been made with a backward inclination.

It is amazing, too, what ingenuity and expense have been expended in some cases to make drawing-room cars uncomfortable. The seats and windows, in many cases, seem to be arranged without any reference to seeing out of the latter. In some of the Wagner cars, with large plate-glass windows, every alternate seat is located so that a passenger must ride backward to see out, otherwise he is confronted with a blank panel. Generally the comfort of the chairs provided in such cases is entirely disproportionate to their cost and to the space they occupy. The occupants are in disagreeable proximity to each other, and there is less seclusion than when each seat is separated from that next to it, as in ordinary cars. With a given amount of money it would seem to be possible to secure a much larger amount of comfort for the same number of people if the car was made with seats of the ordinary plan, but improved in various particulars as has been suggested. The following are offered as general specifications for such a car:

It is to be made with an anteroom or vestibule, with a lavatory at each end, one of them for ladies and the other for gentlemen. Next to each of these let there be a stateroom for parties desiring seclusion, and with a lounge for people who may be ill. Between the staterooms arrange the seats on the plan used in ordinary passenger cars, that is, with reversible backs, but place them from thirty-eight to forty inches apart, measured from center to center, lengthwise of the car. Make the seats twenty inches wide, with a back high enough to reach to the shoulders of a grown person. Use a seat which may be inclined backward, whichever way the car runs. Improve the form of the seat arms, and give adequate and comfortable arm and foot rests. The cushions and upholstered backs to be removable and exchangeable in summer for those made of cane. One window to be provided for each seat, as usual, and to be made as low as is consistent with a comfortable arm rest, and as wide as possible, and yet leave room for a head rest on the side. All the mouldings about the windows and the seat arms and backs to be rounded off so as to be agreeable to the hand or touch. Dust deflectors to be attached at each window, and the sashes of the latter to be provided with means of holding them up in any desired position. As little upholstery to be used as possible, its only object, when used, being that of increasing the comfort of passengers. No textile fabrics whatever to be used for merely decorative purposes. All the "finish" of the car to be designed with reference to the facility of keeping it clean. The ventilation to conform to the plans suggested. The seats all to be numbered in some conspicuous way, and tickets for each to be sold at the same price whether occupied by one or two persons. The objects to be chiefly kept in view, in the design and construction, to be: first, safety, the appliances for which have not been specified; second, comfort; third, cleanliness; and fourth, cheapness. As such a car could seat nearly twice as many people as one of the ordinary drawing-room pattern does, it is plain that for two persons occupying one seat, the charge for each need be only half as much as at present. The features to be avoided should be: first, ostentatious display; second, impure air; and third, propinquity with disagreeable passengers.

But this article must end, not because there are no more evils and discomforts to be enumerated, but because there is not room to describe either them or their remedy, which we may attempt to do at some future time.—*Railroad Gazette.*

MAN ON THE AMERICAN CONTINENT.

Professor Flowers, in a recent lecture on the Anatomy of Man, before the London Royal College of Surgeons, discusses at some length the origin of man on the American continent. The views till lately held as to the peopling of America, may, he says, be grouped under two heads: (1) That the inhabitants of that continent were a distinct indigenous people, created in the country in which they were found, and therefore not related to those of any other land. This is the theory of the polygenistic school, but it is probably not held by many scientific men of the present day. (2) The monogenists mostly believed that they are descended from an Asiatic people, who in comparatively recent times passed into America by way of Behring Straits, and thence spread gradually over the whole continent, as far as Cape Horn, and that their nearest allies must therefore be looked for in the northeast regions of Asia. It has also been thought by those who have held the same general views, that at all events a partial repeopling of the American continent may have occurred from Southern Asia, by way of the Polynesian Islands, or from North Africa, across the Atlantic.

The discovery of the great antiquity of the human race in America, as well as in the Old World, has led to an important modification of these theories. The proof of a very considerable antiquity rests upon the high and independent state of civilization which had been attained by the Mexicans and Peruvians at the time of the Spanish conquest, and the evidence that that civilization had been preceded by several other stages of culture, following in succession through a great stretch of time. But the antiquity of the quasi-historical period thus brought out is entirely thrown into the shade by the evidence now accumulating from various parts of the United States, Central America, and the Pampas, that man existed in those countries, and existed under much the same conditions of life, using precisely similar weapons and tools, as in Europe, during the pleistocene or quaternary geological period, and, perhaps, even further back in time. As in Europe his works are found associated with the remains of *Elephas primigenius*, and other extinct mammals, so in America are they found in contemporary deposits with those of the *Elephas columbi*. If the inductions commonly made from these discoveries be accepted, and the fact admitted that men lived both in Europe and America before the surface of the earth had assumed its present geographical conformation, the data from which the problem of the peopling of America is to be solved are altogether changed.

Recent paleontological investigations, especially those carried on with such great success in the neighborhood of the Rocky Mountains, show that an immense number of forms of terrestrial animals that were formerly supposed to be peculiar to the Old World are abundant in the New; indeed many, such as the horse, rhinoceros, camel, etc., are more numerous in species and varieties in the latter, and therefore the means of land communication between the

two must have been very different to what it is now. Taking all circumstances into consideration, it is quite as likely that Asiatic man may have been derived from America as the reverse, or both may have had their source in a common center, in some region of the earth now covered with sea.

ELECTRICAL HEAT AND POWER.

THERE seems to be little or no doubt that the time is not far distant when we shall be enabled to utilize the mysterious forces of electricity for heat as well as for light, and for mechanical propulsion as well as for metallic deposition. It is not possible to foretell the exact period when these things will be accounted among the accomplished facts, but it appears to be likely that the time is not far distant. The more we learn of electricity, the more its capabilities increase, and we no sooner make it our servant in one capacity than we are led to speculate upon its possible utility in others. A lecture delivered the other evening by Dr. C. W. Siemens is replete with facts and suggestions of this nature. Dr. Siemens, in the first place, has tested the electric arc as a means of fusing metals with the most complete success. He has melted one gramme of steel in this way with units of electric power amounting to within a fraction of the heat-energy residing within a gramme of ordinary coal; that is to say, by means of a dynamo-electric machine, worked by a steam engine, one pound of coal is rendered capable of melting one pound of mild steel. At Sheffield, in the ordinary air furnace, three tons of best Durham coke are consumed in melting one ton of mild steel in crucibles. Further than this, the fusion by electricity attains heat which is practically unlimited; is effected in a perfectly neutral atmosphere; can be readily conducted; the fusing material is within, and of a higher temperature than the crucible—contrary to the results of ordinary fusion. Dr. Siemens has also ascertained that the electric light has the effect of causing plants, vegetables, etc., to grow to a finer development than sunlight, and, he is so convinced on this head that he is specially applying the light at his country residence. With respect to the application of the dynamo-electric current to mechanical propulsion, Dr. Siemens quotes the example of a narrow-gauge railway, laid down in a circle nine hundred yards in circumference, at Berlin, by his brother, Dr. Werner Siemens. Upon this railway a train of three or four carriages has been run by means of a dynamo-electric machine so fixed as to give the necessary motion. The two rails being placed on wooden sleepers were sufficiently insulated to serve for electric conductors, the driving axle being also insulated, so that a current passing through one rail could pass into the driving wheel, thence through the second rail to the station, where both rails were connected with another dynamo-electric machine which was driven by an engine. This little railway worked most successfully, the trains running from fifteen to twenty miles an hour. Its operations have suggested a similar line on a larger scale within the city of Berlin, and Dr. Siemens thinks we shall shortly have electric tramways on roads, as well as in connection with mines. In adits or tunnels the entire freedom from smoke of the electro-motor would be greatly in its favor—in no case more so than on the underground sections of the London railways. So forcibly does this advantage appear that Dr. Siemens states the administration of the St. Gothard tunnel seriously contemplate the use of electricity for running trains through that gigantic undertaking. Should this really be done a great step forward would be made, and we should be so much the nearer the realization of that long-foretold era when all the principal operations of mechanics will be performed by electricity.—*Ironmonger.*

PROGRESS OF AMERICAN TELEGRAPHIC ENGINEERING.

THE lines of telegraph are being extended so rapidly that it is difficult, even for their owners, to state the aggregate quantities at any particular time.

The best information, however, which can be obtained is that on the 1st of January, 1880, there were 119,042 miles of telegraph lines in the United States, and 299,859 miles of wire, without counting those lines specially used by the Gold and Stock Telegraph, and the District, the Fire Alarm and Burglar Alarm Telegraphs in the various cities.

One telegraph company alone, the "Western Union," had, in June, 1879, 8,534 offices, from which were sent and received 25,070,106 messages during the preceding year.

Equally prompt has been the application of the telephone, which, looked upon doubtfully, or only as a toy, when it was first shown by Professor Bell at our Centennial Exhibition four years ago, has so rapidly become a necessity, that there are now in this country 121,000 instruments at work, connecting our business places and dwellings with each other, and with the central offices, by means of which we are almost instantly brought within speaking distance of the persons miles away, with whom we have to transact our business.

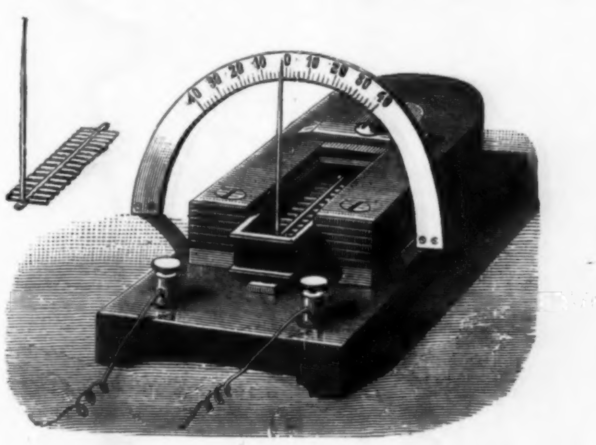
You are so familiar, however, with the telegraph and telephone, that it may be more interesting to you to call your attention to some of the house uses of electricity which are becoming part of our common life. Within the last few years we have been introducing electricity into our houses, and virtually made of it a new domestic servant, by what are called the burglar and fire alarm systems; not only does it ring bells, and summon the other servants (and in recent appliances, keep these bells ringing until the summons are answered), but as a burglar alarm, it is on the watch at night, and in a house properly fitted with these contrivances, the whole or any part can be attached or detached at pleasure. The windows may be left partly open at top or bottom for ventilation, if desired; and once the current turned on, any attempt to alter their position, or to effect an entrance from the outside, causes an alarm which can be stopped only by the person in charge. A glance at the annunciator determines the position of the burglar, or by pressing a knob at the instrument, it shows what doors or windows are open. To accommodate late comers, the front door can be disconnected, or with a special key it may be opened without causing an alarm. In the absence of the family the bell may be made to ring outside, or in a neighbor's house, or at the Police Headquarters; while the clock that calls the servants in the morning, at any hour desired, disconnects such parts of the house they are allowed to use, so as not to disturb the rest of the family.

Applied to safes in counting houses, or to stores containing valuable goods, the burglar alarm rings the bell at Police Headquarters, and at the same time indicates the point of attack. In a recent case in New York, the burglars, who had broken into a silk house, so promptly set off the alarm that they were surrounded by the police and captured as they were taking the goods down from the shelves. The system is being rapidly introduced in stores, counting and banking houses, and in connection with time locks on the safes, affords such good protection as to make watchmen almost superfluous.

Applied to fire alarm, electricity renders still more important domestic service; not only does it advise all the fire engines located in a particular district, whenever an alarm is sounded from a street corner, but it sets machinery at work which unhitches the horses from their stalls, wakes up the firemen (and tumbles them out of bed in some cities), harnesses the horse, lights and fires, and opens the doors of the engine house, so that the machine is ready to start in eleven or twelve seconds after the alarm is sounded; but the fire alarm is also extended to private houses, and there presents itself in the shape of three unobtrusive knobs. Push the first and you summon the fire department; touch the second and a police officer makes his appearance; press the third and a messenger comes to run your errands. Moreover, by means of the pyrostat, should a fire break out during your absence, the expansion of a metallic bar makes an electrical connection, which sets off the alarm and summons the fire engine.—*O. Chanute.*

DEPREZ'S NEW GALVANOMETER.

M. MARCEL DEPREZ has recently exhibited, before the *Société de Physique*, a new galvanometer which seems destined to render frequent services to those persons who have occasion to employ powerful currents. It has been the object of the inventor to produce a needle possessed of exceeding lightness, although at the same time it has to undergo a very energetic magnetic action. The needle here is multiple, and consists really of sixteen or eighteen small parallel needles, mounted on a single axis; and the peculiar aspect of the whole has caused the apparatus to be styled the *fish-bone galvanometer*. The needles are made of soft iron, and are placed (as shown in the figure) between the two parallel arms of a horse-shoe magnet. This powerful magnet magnetizes them and causes them to take a direction parallel with its plane; and so powerfully, too, that if the system of needles be turned by the hand it will suddenly fly back to its position of rest, and vibrate there within very narrow limits. The conductor of the current which is to act on the needle is placed on a small rectangular frame between the needles and the arms of the magnet. As soon as the current begins to pass the needle is observed to suddenly fly to its new position of equilibrium and stay there, without any of those long oscillations, which, in ordinary galvanometers, are the cause of so much loss of time to experimenters. The annexed figure renders it almost unnecessary to say that the instrument is completed by the addition of an index needle moving in front of a graduated arc. In the apparatus here represented, the axis which supports the needles is situated in the horizontal plane of the directing magnet. In still another arrangement this axis is perpendicular to the general direction of the magnet, and the magnetized needle is single and moves in a vertical plane. The result of this arrangement is that the index lies close to the magnet, and so causes the apparatus to take up less space. We have preferred to illustrate the "fish-bone" form, because it can be more readily comprehended from a figure. The conductor may be composed of several spirals of silk-covered wire, as in the apparatus figured, or it may be formed of a single strip of copper, to make its resistance almost null.



DEPREZ'S NEW GALVANOMETER.

But the most important property of this instrument is that of indicating the intensity of the current instantaneously, and the possibility of showing, too, those sudden variations of it that other galvanometers are not capable of exhibiting. This property is due to the extreme lightness of the movable part, and to the great energy of the magnetic action which actuates it. When the needle suddenly flies to its position of equilibrium between the efforts of the magnet and the current, it is, indeed, observed to oscillate for a moment, but its oscillations partake rather of the character of the vibrations of a tuning-fork, and afford evidence of the energy of the action in play. If the galvanometer be placed in the circuit of a Gramme machine, the needle shows through its oscillations all the irregularities of the machine's motion. If the current from a strong pile be caused to pass into a powerful electro-magnet, and it be studied by the galvanometer, its intensity will be seen to vary and increase for a very long time—even for a minute under certain circumstances; that is to say, the complete development of the magnetism is finished only at the end of that period, and during the whole time it lasts the inductive reaction of the electro-magnet is perceptible and decreasing. This remarkable phenomenon, discovered by M. Deprez, shows what services the instrument under consideration is capable of rendering. It only remains for us to say that this galvanometer allows of the intensity of the current being estimated mechanically, and, so to speak, of being weighed. If, in fact, a certain deviation of the needle be produced by causing a weight of 10 grammes to act on a radius of 10 centimeters, we are in a position to assert that a current producing the same deviation exercises an action equal to that of the weight.

VELOCITY OF PROJECTILES IN GUNS.

THE methods that have been tried for ascertaining the law of motion of a projectile in the bore of a gun (with a view to finding the law of pressures developed) give only a small number of points of the curve of spaces traversed in given times, and they involve perforation or other injury to the walls of the gun, so that they are applicable only to large pieces. A new and ingenious method, advantageous in these respects, has been contrived by M. Sebert. In the axis of a cylindrical hollow projectile he fixes a metallic rod of square section, which serves as guide to a movable mass. This mass or runner carries a small tuning fork, the prongs of which terminate in two small metallic feathers which make undulatory traces on one of the faces of the rod (blackened for this purpose with smoke) as the runner is displaced along the rod. The runner, it will be understood, is situated at first in the front part of the projectile, and, while the latter is driven forward, remains in place, the rod of the projectile moving through it. The escape of a small wedge between the prongs of the fork at the moment of commencing motion sets the fork in vibration. It can be easily shown that, owing to the very high speed imparted to the projectile, the displacement in space of the inert mass through friction and passive resistances, which tend to carry it forward with the projectile, is such as may be quite neglected. So that the relative motion of the mass recorded by the tuning fork may be considered exactly equal and opposite to the motion of the projectile. A study of the curves produced guide to the laws of the motion and of the pressures developed by the charge. Evidently the motion of a projectile as it buries itself in sand or other resistant medium may be similarly determined.

MEASUREMENT OF HIGH PRESSURES.

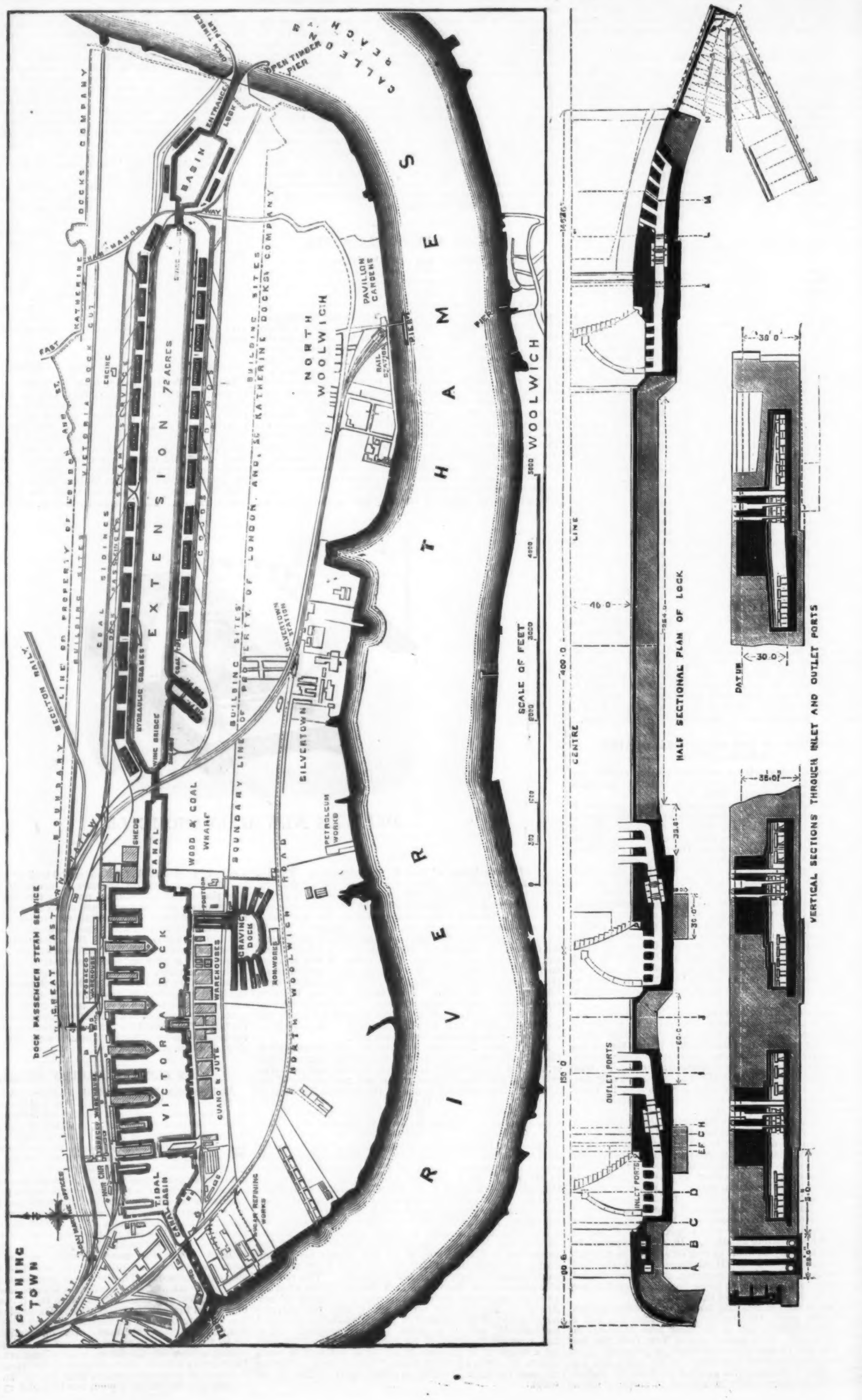
IN Cailletet's experiments upon the liquefaction of gases he used a manometer which enabled him to measure pressures of 1,500 atmospheres with a probable error of not more than one-half of one per cent. It was constructed upon a principle which was suggested by M. Marcel Deprez. When water is compressed under a piston which is perfectly cylindrical, and which works in a cavity drilled in a metallic mass, so that the annular space is very small, the water will escape only very slowly through the narrow passage. With this apparatus, which works without friction, it will be possible, by loading the valve, to weigh the pressures which tend to raise it. The apparatus which he used consisted of a cube of melted steel of 0·2 meter (7·9 inches) in thickness, in which a cylindrical aperture is drilled to receive the steel piston, and adjusted so precisely that the breadth of the annular space between them is less than $\frac{1}{20}$ of a millimeter (0·002 inch). A very sensitive lever receives at one of its extremities weights which exert upon the valve pressures that can be exactly measured. He placed under the piston a piece of gold-beater's skin, which offers an inappreciable resistance to flexure and which prevents the escape of water through the valve. In order to ascertain the precise moment when the piston is raised, he fixed upon the frame an insulated copper screw, against which the lever struck at the very moment when it was moved by the piston. The contact gave passage to a current which sounded an electrical bell. He found by a great variety of experiments that the indications for different pressures were very uniform.—*Ann. de Chim. et de Phys.*

AN ELECTRIC VACUUM SHUNT.

AN ingenious shunt of variable resistance was exhibited by Dr. Stone at the meeting of the Physical Society, on June 26. The variable resistance was formed neither by a set of coils, a platinum-iridium wire, or a tube of water, but by a Torricellian vacuum at the top of a mercury column, the height of which could be increased or diminished at will. The apparatus consists of an ordinary barometer tube of glass 32 in. long, and terminating above in a short vacuum chamber arranged transversely, and closed at either end by adjustable India-rubber stops, through which platinum terminals are passed. The tube is continued beyond this chamber to a stopcock, by which small quantities of air can be admitted into the vacuum. The foot of the tube is connected by a flexible India-rubber pipe to an open glass cistern, like that of a Frankland gas apparatus. This cistern is nearly filled with mercury, which, on the barometric principle, ascends the tube till the height of the column above the surface level in the cistern just balances the pressure of the atmosphere. The cistern is suspended by a cord over a pulley, and counterweighted so that it can be raised or lowered through the whole 32 in. On passing an induction spark through the Torricellian chamber all the discharge is diverted through this shunt. But on admitting a little air by the stopcock to render the vacuum less perfect, and raising or lowering the cistern, so as to lengthen or shorten the mercury column, the resistance of the vacuum can be increased or diminished within wide limits. In this way, according to Dr. Stone, a point can be found at which the

THE ROYAL ALBERT DOCK.

MR. E. M. RENDEL, M.I.C.E., ENGINEER; MESSRS. LUCAS AND AIRD, CONTRACTORS.



induction spark due to breaking contact is shunted through the vacuum tube, while the weaker discharge due to making contact is arrested. The induction current is thus obtained in a single direction, a matter of some importance in physiological experiments.

DESIGN FOR A GATE.

Our engraving shows a gate, from the design of Gorgolewsky, architect, by M. Teeg, metal worker in Berlin, designed for the doorway of a chapel. It is 12 ft. 5 in. high, 10 ft. 4 in. wide.—*The Workshop.*

SUGGESTIONS IN DECORATIVE ART.—DESIGN FOR A GATE.

THE ROYAL ALBERT DOCK.

The Royal Albert Dock is the name given by the London and St. Katharine Dock Company to the largest dock in the world, which, constructed under the name of the Victoria Docks Extension, was opened June 24, 1880, with due ceremony by the Duke and Duchess of Connaught representing the Queen.

The great augmentation in the shipping trade in the Thames, and the ever increasing size of the steamships both for merchandise and passenger traffic, have rendered enlargements in the extent of the dock and dock lock accommodation very necessary, and, perhaps, the presence of the Orient in the Thames a few months since gave the strongest illustration of the fact, taken in connection with the knowledge that other passenger ships of equal size are being constructed. The new dock was really commenced toward the end of 1875, though at that time the intention was only to cut a ship canal from the present dock to Galleon's Reach so as to get an entrance about three and a half miles lower down the river, and to save the navigation of two rather difficult bends. It was, however, soon seen that if a new and larger dock and lock were likely in future to become necessary, they would be much more cheaply constructed, instead of the canal, rather than after the canal was made and in use. The whole of the intended works was thus altered in character, and instead of a depth of 27 ft., as was proposed for the canal, the Orient, which draws 26 ft., showed the necessity for increasing the depth of the dock to 30 ft. The plan of the dock, and its connection with the older dock, we give opposite, together with a half sectional plan and vertical sections of the lock. The passage between the new and old docks is 80 ft. wide. The whole thus forms a magnificent dock 2¾ miles in length, and with an area of 175 acres.

When fully opened it will have two entrances from the River Thames—the present one at Blackwall Point, and the new one at Galleon's Reach, below Woolwich. The new entrance is constructed at the widest part of the river, and protected by two guiding jetties leading into the entrance lock; the curved part of these leading jetties is at the end of the entrance lock as shown in our plan. This lock is about 800 ft. long over all, and 80 ft. wide, and has three pairs of wrought iron gates. The distance between the extreme gates is 550 feet, with a depth of 30 ft. of water over the sills of the outer and inner gates, below Trinity highwater. The lock is thus capable of admitting not only the largest sea-going merchant vessels afloat, but any of the ironclads of the British Navy.

Immediately beyond this lock is an entrance basin of about 9 acres, leading into the main dock by a passage 300 ft. by 80 ft., in which is placed a pair of gates similar to those at the lock, so that this basin, when necessary, may be converted into a 9-acre dock. The passage is spanned by a swing-bridge, carrying the East Ham Manor Way across the new dock. The main dock has an area of about 75 acres, is about 1¼ miles long, and of a uniform width of 490 ft. between the copings.

The dock walls throughout the works are constructed entirely of Portland cement concrete, made and deposited in site. The aggregate length of the dock and passage walls is about 3½ miles. The walls are about 40 ft. high, 5 ft. thick at the top, and from 18 ft. to 19 ft. thick at the base, requiring in their construction some half million cubic yards of concrete, representing 80,000 tons of Portland cement.

On the south side of the main dock, and near its western extremity, two large dry docks are being constructed, almost entirely of Portland cement concrete. The smaller dry dock is about 430 ft. long and 68 ft. wide between the copes, and the larger 510 ft. long and 84 ft. wide. The sills of both are 22 ft below Trinity highwater. The larger dock is capable of admitting the largest ironclads of the Kaiser, Deutschland, and Independencia type. A short distance west of these docks a passage 80 ft. wide connects the extension with the older dock. Under this passage a tunnel, 1,800 ft. long, exclusive of walled open cuttings, has been constructed for the North Woolwich branch of the Great Eastern Railway, the gradients of which are 1 in 50 from each end toward the center, where the rail level is 43 ft. 6 in. below Trinity highwater. In addition to this double line of railway passing under the dock, another double line of railway, as well as the East Ham Road, is carried over the passage by perhaps the largest swing bridge in the kingdom. It has a span of 90 ft. and weighs over 860 tons. Of these works we shall give further details and illustrations in another impression.—*The Engineer.*

AMERICAN COAST AND RIVER NAVIGATION.

It aggregates, says Mr. O. Chanute, for 1879, 2,678,067 tons, of which 1,019,848 tons are propelled by steam. It consists of 13,085 sailing vessels, measuring 804,688 tons, engaged upon the Atlantic and Gulf coasts and on the Pacific coast; and of 1,408 sailing vessels, measuring 282,916 tons, upon the northern lakes.

There are also upon the northern lakes 868 steam vessels, measuring 194,416 tons, together with 170 barges, aggregating 42,226 tons, and 548 canal boats, aggregating 44,774 tons.

On our rivers which empty into the Atlantic and Gulf

coasts there are 2,067 steam vessels, measuring 499,002 tons; 761 barges, with 159,041 tons, and 658 canal boats, with 58,963 tons.

On the rivers which empty into the Pacific we have 267 steam vessels, measuring 77,050 tons, and 87 barges, with 14,596 tons.

While on our western rivers there are 1,199 steam vessels, aggregating 249,380 tons, and 1,373 barges, with 251,015 tons.

Thus it will be seen that of our domestic tonnage, 4,401 vessels out of 22,504, and 1,019,848 tons out of 2,678,067 tons are propelled by steam, and this proportion of steam vessels engaged in our domestic trade, as well as the comparatively short distances over which they ply, enables them to move many times the aggregate tonnage of our foreign trade.

This domestic steam marine presents nearly every variety of practice, from the coasting steamer and the lake propeller, to the western steamboat, some of them of such light draught that it used to be said that they could run on a heavy dew. Our daily experience proves how well adapted the vessels are to our requirements, and the civil war showed that they could be made effective in supplementing a weak war navy.

THE ANTHRACITE COAL FIELDS OF PENNSYLVANIA, AND THEIR EXHAUSTION.*

COAL is monarch of the modern industrial world, with its wonderfully diversified interests, and their ever-expanding development. But, supreme as is this more than kingly power at the present time, comparatively brief as has been the period of its supremacy, and unlimited, in the popular apprehension, as are its apparent resources, yet already can we calculate its approximate duration and predict the end of its all-powerful but beneficent reign. This is especially the case with our limited anthracite; the more widely diffused bituminous having in reserve a much longer term of service—short indeed as a segment of the world's history, but so long, compared with an average human life, as to be of slight practical concern to the present generation.

The territory occupied by the anthracite coal fields of Pennsylvania is but a diminutive spot compared with the area of bituminous coal in Pennsylvania alone, to say nothing of its vast extent in other portions of the United States, and in Great Britain, France, and Belgium. The area of the anthracite of the United States is but 470 square miles, not one-twentieth the size of Lake Erie, while the widespread bituminous coal fields cover twice the area of our four great lakes; the anthracite making but an insignificant showing on the map of the continent. But the comparison with the bituminous area is deceptive, unless the relative thickness of the two is taken into consideration. If the anthracite beds were spread out as thinly as those of the bituminous region, they would cover eight times their present area, or 3,780 square miles. And, again, if the denuded spaces within the borders of the anthracite coal fields were covered with a deposit of coal as thick as we may justly suppose they once were, and as the remaining still are, the available area would be increased to about 2,000 square miles, or 1,280,000 acres; equal to a coal deposit of 92,840,960,000 tons.

Contemplating the number and extent of the coal beds in an illustrative cross-section thereof, a total thickness of 107 feet, distributed in fifteen workable beds, interstratified with a full mile in thickness of rock and shale, we are lost in wonder at the luxuriant growth of tropical plants required to produce this vast amount of compressed fuel, and the mighty processes of nature by which it was placed in its present position. The ingenuity of scientists is taxed to account for this wonderful accumulation of fuel, once vegetable, now mineral; once waving in fresh green beauty on the surface of the earth, now buried under hundreds of feet of solid rock; once growing in a level deposit of mud so plastic that the lightest leaflet dropping on its surface left its impress, now the mud hardened into slate, and the rank vegetation changed to hard and glittering coal, rising and falling in geologic hills and valleys, surpassing in number, depth, extent, sharpness of flexure and acuteness of angle, anything visible in the light of upper day.

Some slight idea of the growth of these ancient forests may be gained from the computation that to form only one of these large beds of coal required a deposit of vegetable matter perhaps one hundred feet in thickness. What shall we say then to the amount of vegetation stored away in the Mammoth Bed, which extends through all three of the anthracite coal fields, covering an area of 300 square miles, with an average thickness of twenty feet, and containing, it is estimated, 6,000,000,000 tons of coal?

Not less wonderful and interesting than the coal deposits is the grand floor of conglomerate which underlies them; a vast sheet of rock, infinitely old, composed of fragments of other rocks infinitely older, bound together by an almost imperceptible cement which holds them so firmly that gunpowder will scarcely separate them. Whence came this great sea of pebbles, water rounded and water-borne to their present resting place? We find them now as the current has dropped them—masses of silex as large as ten-pound cannon balls, and almost as round, so shapely have they been worn by the action of some ancient current. These were deposited first, and then, in regular order, trending to the southwest, came sizes graduated down to those of a pea and grains of sand.

This more than marble floor bears few saurian footprints; scarcely an impress of bird or beast or fish, or sign of animal life. Nothing but a bed of almost pure silica; a solid foundation on which to build up the mass of rock and the fossil fuel that we call anthracite, older than the hills and predestined for the use of coming man.

The pebble-laden flood ceased, and was followed by placid waters and gentle currents, bringing fine mud and silt to cover the rocky bed. Then the waters drained away, or the land rose, until fit for vegetable life, it was covered with the mighty flora of the carboniferous period. Again it sank, carrying with it its store of decayed and decaying vegetation, and another flood of pebbles rolled over it.

How many ages were consumed in the process so briefly described—who can tell? Nature's operations are on too vast a scale, and her working time too long to admit of hasty activity in the production of results. It may well be said that all the years since the creation of man would be too short a time to produce a bed of coal.

However long the process just described, it was of frequent repetition during the coal period; and thus we find pebble beds, slate, and coal in often recurring series, as in the following cross-section made at Trevorton, the western terminus of the middle anthracite coal basin.

But through all the changes of time and scene, the upheavals and depressions, the submergence and emergence of the land, we find a remarkable uniformity in the growth of plants, continuing almost without change throughout; sigillaria, lepidodreuda, ferns, etc., following their kind, unvaried through successive series of strata, in each leaving their characteristic impress of stems and foliage on the enduring tables of the rocks. The coal flora is rich in variety and of great beauty, as Professor Lesquereaux's careful research abundantly testifies. Their exact forms show a quiet condition of the waters, at least during the deposit of the slate covering of the coal beds; and the intervening rocks show the same facts. When impressions of the flora are found in the solid coal itself, we have the same evidence; but this is of rare occurrence. The best impressions usually occur in the smooth top slate covering the coal beds.

When we examine the arrangement of the Pennsylvania anthracite beds we wonder at their complexity. Without evidence of volcanic disruption, not even a protruded trap-dike, or extensive up or down throw, we often find contortions and disturbances of the strata. The beds are rarely horizontal, but lie at every angle, and sometimes even pass the perpendicular and fold back upon themselves. In places they occupy our mountain summits, nearly 2,000 feet below the level of the sea, and again depressed more than 3,000 feet below it, making a variation of a mile in altitude. Yet the coal, which is the frailest material in all this rocky mass, is not destroyed, but generally in good workable condition—solid, almost crystallized, almost pure carbon, and frequently in beds too thick for economical working.

Faults in the anthracite beds usually have a northwest and southeast direction, and show the beds compressed, and again correspondingly enlarged, but no sudden dislocations or breaking off of the strata. Soft coal, or dirt faults, are of common occurrence in the red ash or softer coals in the western end of the anthracite fields.

The colored ash of burned coal is due, doubtless, to the presence of iron; but why this coloring matter is confined to the upper series of coals in the eastern portion of the range, and to the lower beds in the western district; and why there is a gradation in the middle district, from white ash in the lower, to gray in the middle and red in the upper beds, are problems yet to be solved.

How shall we account for the great disturbance of the strata from their original horizontal position? Was it caused by volcanic force—of which there are no indications—or by contraction of the earth's crust? And if the latter, why is it confined to the anthracite region, and not extended to the bituminous also? And how shall we explain the isolation of the smaller coal fields, like those of Rhode Island, Richmond, Va., or Deep River, in North Carolina; or the disproportion in quantity between the limited area of anthracite and the widespread fields of bituminous? Why do we find an abundance of shells and remains of animal life in the latter, and rarely any in the former? A few saurian footprints recently found at the Ellangowan Colliery, in Schuylkill County, and a few shells found in the Glendower Pit, in the Wyoming Valley, are signal exceptions to an almost universal rule. After an exploration, covering the period from 1835 to 1850, Prof. H. D. Rogers and his corps of assistants failed to find any other specimens. Neither has Prof. Lesley in his new Geological Survey of Pennsylvania, or the writer in an experience of 30 years' residence and active service, underground and in surface explorations, been any more fortunate.

Nor in all this area do we find a single workable bed of iron or limestone, and scarcely a covering of fertile soil. The coal once exhausted, nothing is left but the worthless shell, desolate and deserted.

The anthracite region, mainly confined to one-sixth the area of the four mountainous counties of Luzerne, Schuylkill, Carbon, and Northumberland, in Pennsylvania, is crowded with an industrious population which increased fifty-one per cent. in ten years; that is from 229,700 in 1860, to 344,771 in 1870; while the four adjacent agricultural counties of similar area increased in the same time from 310,542 to 339,942, only six per cent. It is located on the parallel of 40° 30′, one hundred miles from any seashore, no part of it less than 500 feet above tide—near the head waters of the large rivers that drain it—the Susquehanna, Schuylkill, Lehigh, and Delaware. The noisy trains crossing the valleys and climbing the mountains all verge, day and night, to these hives of industry, where multitudinous steam engines are hoisting and pumping, and breakers crushing. Thousands of miles of railroad thread the surface and dive into the interior, to roll out the black diamond flood in millions of tons of fuel to warm and employ the nation.

The fearful loss of good material involved in mining and preparing anthracite, as shown in the accompanying tables, though greatly to be deplored, seems to be almost inevitable. The disposition of the coal in large solid beds and in highly inclined positions involves strong supports to keep the superincumbent mass from crushing and closing the avenues to the mines; and these supports must consist of massive pillars of the solid coal itself. Wooden props, however ponderous and strong, can only be used for the minor supports. Some of this pillar coal is ultimately removed, but much of it is inevitably lost, especially in the larger beds, which frequently range from 20 to 40 feet in thickness, and are often inclined at an angle of from 40 to 70 degrees.

It is estimated that not more than 66 per cent. of the coal is ever taken out from the mines. That which is brought to the surface is run through a huge structure from 80 to 100 feet high, very appropriately called a "breaker," ingeniously contrived for the destruction of coal. There are over 300 of these immense buildings in the anthracite region, costing on an average $50,000 each, or an aggregate of $15,000,000. To the top of these the coal is hoisted, and then descends through a succession of rolls and screens, emerging at the bottom, in a series of assorted sizes, from huge blocks of lump coal to unmerchantable dust, which forms a grievously large proportion of the whole. This process involves a loss of good coal, equal to 20 or 25 per cent. of the entire quantity mined. For the coal wasted in mining, say 40 per cent., and in preparing, 25 per cent., no one is paid; it is a total loss to landowner, miner, and shipper.

Plans for utilizing the waste coal dirt, or culm of anthracite collieries, have been frequently suggested, but none have come into general use. The Anthracite Fuel Company, at Port Ewen, on the Hudson, in 1877, used 90 per cent. coal dust and 10 per cent. fuel pitch, and made 300 tons of fuel per day, consuming over 50,000 tons of culm. The Delaware and Hudson Company also use at their mines 60,000 tons per annum. They now ship all their coal down to pea sizes, and consume the culm in generating steam. If all our coal companies would follow this excellent example it would enable them to sell half a million tons more coal, and burn the same amount of refuse, thus earning or saving half a million dollars per annum, to add to their revenues. The Philadelphia and Reading Railroad Company has recently introduced a method of burning coal dust in the furnaces of its engines, and the plan appears to meet with success.

The amount of water which drains into a mine from a mile or more of surface is enormous, for the average amount of rain and snow fall is 58,840 cubic inches per square yard annually, and the mines are liable to absorb not only the rain fall on the surface immediately over them, but all that which by contour of the surface, or by converging strata, tends toward them. On an average possibly five tons of water are hoisted for every ton of coal raised—another loss chargeable to mining.

The preponderance of waste coal, illustrated by the accompanying tables, seems excessive; but the writer's experience in surveys of certain tracts of land, and in preparing maps which show the area exhausted, compared with the amount marketed from ten or more collieries, in a period of 20 years, proves that the loss is not over-estimated, especially in the Mammoth Bed, whose average thickness is 25 feet. An eight-foot bed of coal yields much better in proportion. When they exceed six or eight feet in thickness, especially if steeply inclined, they are not only expensive to mine, but a large proportion of the coal must be left to support the rocky roof.

The bituminous coals, particularly those of the United States, are not subject to these serious losses, and are quite cheaply mined and prepared. No breakers are required, as the only division is into coarse and fine coal, which are easily separated by screens; and the fine coal can be readily converted into coke, making a better condensed fuel than the coal in its natural shape. The bituminous beds are nearly horizontal and rarely more than six feet thick, so that it is not necessary to leave extensive pillars; and as the coal is above water level, or in shallow basins, it is not necessary to put up extensive hoisting and pumping machinery. The simple, natural ventilation of American bituminous mines also does away with the extensive and costly appliances for this purpose of anthracite mines, in spite of which so many miners annually fall victims to the noxious gases.

AND NOW AS TO THE HARVESTING.

The total amount of coal still to be mined, according to the accompanying tables, is 26,361,076,000 tons. The total waste, as experience has shown, is equal to two-thirds of the coal deposit, and reaches the appalling amount of 17,574,050,666 tons, leaving us only 8,787,075,533 tons to send to market. In all our calculations of anthracite we have counted the area as if in a level plain, and made no allowance for the undulations which must necessarily increase the amount of coal. But as many of the flexures are abrupt and broken, making much faulty and refuse coal, it will cover any over-estimate of area or thickness we have made in our calculations.

Our tables show that 360,017,817 tons have been sent to market in the 58 years from 1820 to 1878, inclusive. Our consumption now amounts to 20,000,000 tons annually. The increase of production for the past ten years has been 187,112,857 tons. At this rate we shall reach our probable maximum output of 50,000,000 tons in the year 1900, and will finally exhaust the supply in 186 years.

The present product of the anthracite coal fields is (1878) as follows:

Southern................	50	Collieries....	6,282,226 tons.
Middle..................	161	"	3,237,449 "
Northern.......	132	"	8,085,587 "
Total................	343	" ...	17,605,262 "

At this rate the eastern end of the northern field is being rapidly exhausted. The middle field, too, which contains the lower productive coals, is likely to cease extensive mining about the year 1900; while the western portion of the northern field, extending from Pittston to the western end, and the southern field from Tamaqua to Tremont, comprising about 100 square miles, which contain more coal beds and deeper basins, must furnish the supply for the coming years.

Partially successful experiments have been made to use petroleum as a substitute for coal to some extent. But is it not already evident, under the reckless prodigality of production, that this occult and mysterious supply of light and heat and color will be exhausted before the anthracite, and can, at best, only temporarily retard the consumption of the latter?

As already intimated, the question of the exhaustion of our coal supply is scarcely more at the present time than a curious and interesting calculation. It has not yet become so grave and portentous as in Great Britain, where a commission, with the Duke of Argyll, Sir Roderick Murchison, and Sir W. G. Armstrong at its head, was recently appointed by Parliament to ascertain the probable duration of the coal supplies of the kingdom. There it is serious indeed; for when Britain's coal fields are exhausted, her inherent vitality is gone, and her world-wide supremacy is on the wane. When her coal mines are abandoned as unproductive, her other industries will shrink to a minimum, and her people become familiar with the sight of idle mills, silent factories, and deserted iron works, as cold and spectral as the ruined castles that remain from feudal times.

The modern growth and ultimate decadence of this great empire may be calculated from the statistics of her coal mines. In 1800 her coal product was about 10,000,000 tons; in 1854 it was 64,661,401 tons; and in 1877 it swelled to 136,179,968 tons. This period was a time of continued prosperity, when England ruled the world financially and commercially. In the 23 years from 1854 to 1876, inclusive, she produced the enormous quantity of 2,210,710,091 tons of coal; and, more wonderful still, exported only 222,196,100 tons—say ten per cent.—consuming the rest within her own borders.

The average increase of her annual output has been $3\frac{1}{2}$ per cent. Will it so continue? Or has she reached the summit of her industrial greatness and commercial supremacy, and will they now decline, and with it, her naval and military power, the subservient agent, and, to a large extent, the creature and result of those great interests? Her coal product in 1878 was less by 1,587,905 tons than that of 1877. Is this the beginning of the inevitable decline? There is reason to believe further, on account of the great depression in business, that the production of 1879 will be less than that of 1878.

Our anthracite product, compared with the coal product of Great Britain, is so small as to really seem insignificant. The English commission counts as available all coal beds over one foot thick—we count nothing under two and a half feet thick, nor below 4,000 feet in depth—showing a net amount in the explored coal fields of 90,207,285,398 tons;

* Read before the American Association for the Advancement of Science, at Saratoga, September 1st, 1879, by P. W. Sheafer, M.E., of Pottsville, Pa.

estimated amount in concealed areas, 56,273,000,000 tons; total, 146,480,285,398 tons, distributed as follows:

	Explored.	Unexplored.	Total.
England....	45,746,930,555	56,246,000,000	101,992,930,555
Wales......	34,461,208,913		34,461,208,913
Scotland....	9,843,465,930	No estimate.	9,843,465,930
Ireland	155,680,000	27,000,000	182,680,000
Total....	90,207,285,398	56,273,000,000	146,480,285,398

The exhaustion of this magnificent mass of coal at this present rate of increase, viz.: three and a half per cent. per annum, is estimated by Professor Jevons as follows:

1876, actual output....................	133,300,000 tons.
1886, estimated annual output...........	186,600,000 "
1896, " " "	261,200,000 "
1906, " " "	365,700,000 "
1916, " " "	512,000,000 "
1926, " " "	716,800,000 "
1936, " " "	1,003,500,000 "

Thus in sixty years the output would be nearly eight times the present amount, and about one-fourth of the total amount to be found in great Britain.

This vast estimate seems too enormous. It does not allow for great loss when cost of labor and much competition will prevent the working of small coal beds under two feet in thickness, or for the cost of mining when from 2,000 to 3,000 feet deep. Nor is it possible that Great Britain's industries and export trade combined will ever require so great a quantity. Modern discoveries and improvements, in applied science, tend to diminish the consumption. The 8,000,000 tons annually required for gas works may be materially reduced by the use of the electric light. The domestic consumption, now equal to one-fourth the product, or 33,000,000 tons a year, may increase. But will not the iron manufactures be on the wane, and her coal exports—now ten per cent. of her coal product—fall off as those of other countries increase?

We have about 340 collieries and produce 20,000,000 tons per annum, or about 60,000 tons each. Great Britain has nearly 4,000 collieries, and mines 132,000,000 tons, or 33,000 tons per colliery. The greater the yield per colliery the less the expense in mining. If we decrease the number of mines and increase their capacity not only to raise the coal, but to exhaust a constant current of foul air and dangerous gases, clouds of powder smoke, and millions of gallons of water, we will reduce the cost of mining. Most of the anthracite mining in the United States is now done at a less depth than 500 feet vertical; but as the coal nearer the surface becomes exhausted, the mines must go deeper and become more expensive. What folly it is to boast of our world's supply of anthracite, and feverishly endeavor to force it into foreign markets, when we can so readily foresee its end! Would it not be wiser to limit its product, restrict its sale to remunerative prices, and consume it at our own firesides and in our own manufactures?

The monopoly of the anthracite coal fields by some seven corporations, which, according to the accompanying tables, now control about two-thirds of the whole, and the best coal area, must prove, under economic management, a profitable investment for their stockholders. Mining, selling, and transporting their own coal, as they do, individual enterprise cannot hope to compete with them, and must vanish from the ground, and their only rivalry will be with each other and with the bituminous trade. Fortunately for the public, this rivalry will always be keen enough to keep the price of coal at a fair low rate of cost and profit.

The coal resources of Great Britain are all developed now and in process of depletion; while in this country, when our 470 square miles of anthracite are exhausted, we have more than 400 times that area, or 200,000 square miles of bituminous, from which to supply ourselves and the rest of mankind with fuel. The coal product of the world is about 300,000,000 tons annually. The North American continent could supply it all for 200 years. With an annual production of 50,000,000 tons, it would require twelve centuries to exhaust the supply. But with a uniform product of 100,000,000 tons per annum, the end of the bituminous supply would be reached in 800 years. What the annual consumption will be when this continent supports a teeming population of 400,000,000 souls, as will be the case some day, must be left to conjecture. But with half that population, as energetic, restless, and inventive as our people in this stimulating climate have always been, under the hopes of success, such a country as this constantly holds out to tempt ambition and reward enterprise, it is a very moderate estimate, guided by the actual output already reached in Great Britain, to suppose that there will be ample use for one hundred million tons a year of bituminous coal for home consumption alone.

If it be true, as Baron Liebig asserts, that civilization is the economy of power, we have it in our immense areas of bituminous coal. There is no known agent that can answer as a substitute for the vast power and almost limitless usefulness of coal in its general adaptation to the wants of man; and that nation will maintain the foremost rank in enlightened modern civilization which controls, to the fullest extent, while it lasts, this wonderful combination of light and heat and force. We are wiser than our fathers; and from the modest but sublime altitude to which we are lifted by physical science, and the far extended range of mental vision which it opens up to us, we can see farther into the plans of Providence than those who went before us, and can conjecture the early, if not the remote, future of the human race in our land and in other lands.

Happy that people whose legislators study the best mode of developing the natural resources of their country, and whose great men become great by improving the condition and promoting the welfare of the human race! The greatest of England's five Georges was not either of those who wore the crown, but plain George Stephenson, of Manchester, who rolled the world farther along the path of progress than all the others; and none of the royal Jameses did half so much for the civilization of his country as James Watt, whose boyish study of the steam tea-kettle developed the giant power that does the world's work with an energy that is tireless and irresistible.

NEW USE OF NICKEL.

NICKEL is more infusible than iron, more malleable, more ductile, tougher, and not affected by atmospheric influences. M. Fleitmann has found that when melted it absorbs some carbonic acid, and if a small quantity of magnesium is then added the metal becomes remarkably ductile and malleable. It can be drawn out into very fine wire or beaten into extremely thin leaves, and can be readily welded either to nickel or to iron.—*Chron. Ind.*

DISCOVERIES OF MINERALS IN WESTERN NORTH CAROLINA.*

By JOHN T. HUMPHREYS, M.A.

DURING the month of May, 1877, while on a buggy trip from Statesville to Hickory, I discovered from my buggy a deposit of drift gravel along the roadside, a few miles east of the town of Hickory, which promised something handsome in the line of quartz crystals. After having removed my family to Hickory, which delectable and well-beloved town was to be so dearly enhanced in value to me, I started out on the 4th day of the following June (1877) to trace out the indications offered by that pile of gravel scattered promiscuously along the roadside. By actual measurement, the belt of drift deposit, extending a long distance with a northeast and southwest trend, was three-quarters of a mile in breadth. My first diggings were on the lands of Mr. E. Balch, who, under my personal supervision, soon reached a pocket of water-bearing smoky quartz crystals, at a depth of two feet under ground. Here I found my first basal plane on quartz crystals, smoky and clay tessellated. Devoting my entire time to field work in the drift belt of this neighborhood, I examined nearly fifty different localities, found either by myself or by workmen trained under my personal teaching. The result, by the 1st of January, 1878, was the discovery of thirty-five new localities for the following list of minerals, together with a determination by myself of the separate species:

Water-bearing crystals of quartz.
Carbon dioxide bearing crystals of quartz.
Smoky quartz crystals.
Amethyst quartz crystals.

Quartz crystals inclosing layers of red clay.
" coloring matter of various hues.
" other crystals.
" small prisms of mica.
" pyrites.
" rutile.

The most magnificent specimen of the last, 7 x 4 inches, inclosing three beautiful rosettes of rutile, I presented to my friend, Mr. Wilcox, of Philadelphia.

Having seen in the cabinets of my friend Stephenson, of Statesville, a number of so-called seventh planes on the prisms of quartz crystals, which he obtained in Alexander County, I went diligently to work for such localities in Catawba County. My search, at first, was fruitless, but I observed a singular feature in some of the crystals dug from the first pocket I had discovered in this county. This feature consisted of a well-marked plane, parallel to the lateral axis, or a plane truncating the *pyramid* at a right angle to the prism. This, I claim, is the first American locality for quartz crystals with basal planes; the locality itself, as also the observation of the peculiar planes, being my own original discoveries. I delayed the publication of my secret through fear of attracting attention to the locality. This was in June, 1877. In July and September following, I had discovered fifteen new localities in the vicinity for water-bearing quartz crystals, obtaining as many as 550 specimens. During the same months, I obtained nearly seventy crystals with the basal planes. My work continued through the months of October and November, when the winter caused a suspension of field labors.

In the month of March, 1878, my field explorations were renewed, and, with almost continuous work, extending through the months of April, May, June, July, August, September, and October, of the same year, I discovered and worked on fifty-six different new localities, yielding the same species before mentioned, with the addition of—

Black tourmaline.
Brown tourmaline.
Green beryl.
Melanite (garnets) in muscovite.
Sagenite (meshed rutile).
Acicular rutile.
Rutile in amethyst.

The last-named species I also claim as having first discovered in this country, if not in the world.

The result, then, of my field work in Catawba County, N. C., from the 4th day of June, 1877, to the 1st day of November, was the discovery of ninety-one new localities for minerals and the scientific determination of the following list of species obtained from these localities, new to science:

Quartz crystals:
Drusy,
Reniform,
Botryoidal,
Asteriated,
Acicular,
Avanturine,
Filiform,
Reticulated,
Water-bearing,
Carbon dioxide bearing.
Inclosing layers of red clay,
" coloring matter of various hues,
" other crystals,
" microlites (after Vogelsang),
" pyrites,
" small prisms of mica,
" rutile,
Amethyst, inclosing acicular rutile,
" " sagenite (rutile).

Many of these were twins, geniculations, double terminals, and in groups, varying in colors from black (of various shades) to the most pellucid variety, including green, yellow (citrine), smoky, purple, milky, and almost every tint known to chemistry.

Crystallographically, I have discovered in these new localities the following list of forms:

Basal planes,
Hexagonal pyramids,
Dihexagonal "
Trigonal "
Trigonal prisms,
Rhombohedrals,
Trapezohedrals, and
Hemimorphic forms.

The weight of these separate crystals runs from 1 grain to 100 lb.

There are two very singular groupings among these crystals; the one being a number of amethyst crystals grouped upon a group of milky crystals, the other (resembling Fig. 335, page 101, in E. S. Dana's Text-Book of Mineralogy, edition of 1877) being a series of quartz crystals all in a parallel position on the prism and pyramid faces of a group of acicular milky quartz crystals.

I believe I have discovered in this belt more than two-thirds of the forms of quartz known to science. This, however, I will determine before the year closes.

On a group of thirteen smoky crystals, having unitedly fifty-two easily discernible and movable bubbles and nine different basal planes, there is one crystal with a basal plane and a cavity inclosing a gas, a liquid, and a solid—the finest and most interesting specimen of its class which has ever been discovered.

In the months of July and August of this year (1878), I discovered two new localities in Burke County, for basal planes on quartz, three new localities for sagenite and the golden colored rutile, two new localities for liquid-bearing crystals, one new locality for corundum crystals with a border of fibrolite and inclosed in micaceous schist, one new locality for tourmaline, one new locality for aqua-marine; and in conjunction with Mr. W. E. Hidden, I discovered forty-one different minerals in a few ounces of Brindlettown gold sands, being by far the largest and rarest number ever obtained at one time by an examination of these celebrated sands:

Titanium,	Zircon,
Titanite,	Thorium,
Menaccanite,	Graphite,
Rutile,	Corundum, white,
Anatase,	" blue,
Octahedrite,	" red,
Ilmenite,	" gray,
Brookite,	" yellow,
Iron,	Feldspar,
Limonite,	Albite,
Mag. iron,	Actinolite,
Granite,	Tourmaline,
Gneiss,	Schorl,
Itacolumite,	Epidote,
Quartz,	Beryl,
Garnet,	Tremolite,
Schist,	Hornblende,
Monazite,	Soapstone,
Amethyst,	Kyanite,
Gold,	Cairngorm stone.

For my labor, during a period of more than three years, I am amply repaid by the following resultant facts:

I now own the rarest, richest, and most extensive cabinets of North Carolina minerals in the entire world.

I have probably discovered the first (and in several localities) basal planes on quartz in this country.

I have discovered the first specimens of sagenite in royal purple quartz crystals, grouped and otherwise, in America, and, perhaps, in the world.

I have discovered the rarest and best specimens of water-bearing crystals, grouped and otherwise, in the world.

I have, possibly, discovered the first evidence of suspended crystallization in a crystal of rutilated quartz.

I have probably discovered the only specimen of a quartz crystal containing a gas, a liquid, and a solid, in the same cavity, quite large and freely movable.

My cabinets contain the largest and most varied number of the carbon-silicon group known to the science.

This paper, in conclusion, is merely to place on record the result of my three years' field work amongst the minerals of North Carolina, until I can elaborate, with engravings, in a substantial book form.

* A paper read before the regular meeting of the Buffalo Academy of Natural Science, Buffalo, N. Y., June 11, 1880.

A VIKING'S SHIP.

A RECENT antiquarian discovery of a most remarkable nature has put the scientific world of Scandinavia in commotion, and is attracting the general attention of the Scandinavian nations, fondly attached to their venerable history and ancient folk-lore, and full of devotion for the relics of their great past.

In the southwestern part of Christiania Fjord, in Norway, is situate the bathing establishment of Sandefjord. The way from this place to the old town of Tonsberg conducts to a small village near Gogstad, near which is a tumulus or funereal hill, long known in the local traditions under the name of King's Hill (*Kongshaug.*) In the flat fields and meadows stretching from the fjord to the foot of the mountains this mole, nearly 150 feet in diameter, rises slowly from the ground covered with green turf. A mighty king, it was told, had here found his last resting-place, surrounded by his horses and hounds, and with costly treasures near his body, but for centuries superstition and the fear of avenging ghosts had prevented any examination of the supposed grave, until now the spirit of investigation has dared to penetrate into its secrets. The result has been the discovery of a complete vessel of war, a perfect Viking craft, in which the unknown chieftain had been entombed.

The sons of the peasant on whose grounds the tumulus is situated began in January and February this year an excavation; they dug down a well from the top, and soon met with some timber. Happily they suspended their work at this point, and reported the matter to Christiania, where the "Society for the Preservation of Ancient Monuments" took up the task, and sent down Mr. Nicolaysen, an expert and learned antiquary, to conduct the further investigation. Under his able guidance the excavation was carried on in the months of April and May, and brought to a happy conclusion, revealing the whole body of an old Viking vessel, 74 feet long between stem and stern, 16 feet broad amidships, drawing 5 feet, and with 20 ribs. This is by far the largest craft found from the olden times.

In 1863 the Danish Professor Engelhardt dug out from the turf-moor at Nydam, in Schlesvig, a vessel 45 feet in length, and in 1867 another was found at Tune, in Norway, 43 feet long; but neither of these can in completeness or appointment be compared to the craft now excavated at Gogstad. The tumulus is now nearly a mile distant from the sea, but it is evident from the nature of the alluvial soil, that in olden times the waves washed its base. The vessel had been consequently drawn up immediately from the fjord, and placed upon a layer of fascines or hurdles of hazel branches and moss; the sides had then been covered with stiff clay, and the hole been filled up with earth and sand to form the funereal hill. But the craft is placed with the stem towards the sea. It was the grand imagination of the period that when the great Father of the Universe should call him, the mighty chieftain might start from the funereal hill with his fully appointed vessel out upon the blue ocean.

In the stem of the ship, first disclosed to the eye, several interesting objects were found. A piece of timber proved

to be the stock of the anchor; it was perforated to hold the iron, but of this no more was found than a few remnants. In the bottom the remains of two or three small oaken boats of very elegant shape were placed over a multitude of oars, some of them for the boats, others, 20 feet long, for the large craft itself. The form of these oars is highly interesting, and very nearly like that still in use in English rowing matches, ending in a small finely cut blade, some of them with ornamental carvings. The bottom deals, as well preserved as if they were of yesterday, are ornamented with circular lines. Several pieces of wood had the appearance of having belonged to sledges, and some beams and deals are supposed to have formed compartments dividing the banks of the rowers on each side from a passage or corridor in the middle. In a heap of oaken chips and splinters was found an elegantly shaped hatchet, a couple of inches long, of the shape peculiar to the younger Iron Age. Some loose beams ended in roughly carved dragons' heads, painted in the same colors as the bows and sides of the vessel—to wit, yellow and black. The colors had evidently not been dissolved in water, as they still exist; but as olive oil or other kinds of vegetable oil were unknown at the time, it is supposed that the colors have been prepared with some sort of fat, perhaps with blubber.

As the excavation proceeded, the whole length of the vessel was laid bare. All along the side, nearly from stem to stern, and on the outside, extended a row of circular shields placed like the scales of a fish; nearly 100 of these are remaining, partly painted in yellow and black, but in many of them the wood had been consumed and only the central iron plate is preserved. From the famous tapestry of Bayeux it is well known that the ancient viking vessels had these rows of shields along the freeboard, but it was supposed that they were those used by the warriors in the strife, and only placed there for convenience. It is now clear that they had only an ornamental purpose, being of thin wood, not thicker than stiff pasteboard, and unable to ward off any serious hit from a sword.

In the middle of the vessel a large oaken block, solidly fastened to the bottom, had a square hole for the mast, and several contrivances show that the mast was constructed for being laid down aft. Some pieces of tow and a few shreds of a woolen stuff, probably the mainsail, were found here. In this part of the chamber was built the funereal chamber, formed by strong planks and beams placed obliquely against each other and covering a room of nearly 15 feet square.

Here, just as expectations were raised to the highest pitch, a bitter disappointment awaited the explorers. Somebody had been there before them. Either in olden times, when the costly weapons of an entombed hero tempted the surviving warriors, or in some more modern period when the greediness for treasure was supreme in men's minds, the funereal hill has been desecrated, its contents pilfered and dispersed, and what has been left is only due to the haste and fear under which the grave robbers have worked. A few human bones, some shreds of a sort of brocade, several fragments of bridles, saddles, and the like in bronze, silver, and lead, and a couple of metal buttons, one of them with a very remarkable representation of a cavalier with lowered lance, are all that has been got together from the heaps of earth and peat filling the funereal chamber. On each side of it, however, were discovered the bones of a horse and of two or three hounds.

In the forepart of the ship was found a large copper vessel, supposed to be the kitchen caldron of the equipage, hammered out of a sole piece of copper, and giving a most favorable proof of that remote period's handicraft. Another iron vessel with handles, and with a chain for hanging it over the fire, lay close to a number of small wooden drinking cups. The detailed account of all these objects would claim too much space. It was originally the intention to dig out the whole craft from the hill and transport it to the museum at Christiania. A large proprietor of the neighborhood, Mr. Treschow, offered to pay the expense. But on closer examination and after consultation with one of the constructors of the navy it was considered unsafe to attempt such a dislocation. It is now the intention to leave the craft where it was found and to protect it against the influence of the weather by building a roof over the hill, only carrying to the museum at Christiania the smaller objects. The Government has at once consented to defray the expenses necessary for the purpose.

As to the time when the tumulus was thrown up, there is no doubt among the antiquarians that it dates from the period termed the "younger Iron Age," distant from our day nearly a thousand years, or a little more. We shall have to carry our thoughts back to about the year 800, when Charlemagne was crowned Emperor at Rome, but when Norway was still divided among the wild chieftains and sea kings vanquished towards the close of the ninth century by the great Harold the Fair-haired, the founder of the Norwegian state and nation.—*London Times.*

RELICS OF AN ANCIENT WRECK.

The *Natal Mercury* says: "Mr. Sydney Turner, of Durban, and Lieutenant Beddoes, late of the Natal Pioneers, have been at work for several weeks endeavoring to recover valuable things said to have gone done in the wreck of the Grosvenor, Indiaman, which occurred, we believe, in 1782, on a point of rocks about twenty-five miles on the Natal side of St. John's River, where the sea breaks very heavily. There is an old rumor that on board the vessel were General or Colonel Campbell and two daughters. These daughters are said to have been made wives by the natives, and it is told of them that, when their friends after some time found them out, they refused to leave from feelings of shame. Certain it is that near the Umgazi River are living a small clan of light-colored Kaffirs, many of whom are supposed to be descendants of some Europeans wrecked near St. John's River. Mr. Turner has shown us the articles recovered from the rocks, chiefly by dynamite blasting. There are about fifty gold coins, about one hundred silver, and several copper ones. Many of the coins were found cemented into oxidized iron, the ship having been ballasted with pig iron. The gold pieces are about the size of a sovereign, but are much thinner; and although they have been so long exposed, several of them are in a wonderfully good state of preservation. The larger gold coins are supposed to be Portuguese. On one side there is a representation of two standing figures, one holding a staff surmounted by a crucifix. The reverse side is not unlike the spade side of an old guinea. In somewhat of a diamond shape there is another standing figure having a halo round the head and encircled by stars. The designs are similar in most of the gold coins, but the inscriptions vary. On one side of the best specimens are the following letters and words, as far as we can distinguish them: 'S. M. Venet. Franc. havred, D. V.' On the other side there appears to be 'Regis Islib Luca, Sit. X. P.B. DAT. Q.T.V.' A number of little gold coins are quaint-looking pieces, not unlike ordinary sized shirt studs. They bear the effigies of Indian gods, and a large copper token has the world on it with the zodiac. The silver coins are nearly all of one size, that of a shilling, and they appear to be of a very ancient date. They are very thick, and bear on them Indian characters, which we have had translated to us by a competent authority in Durban as 'Akbar Shah,' the name of the first king of the Delhi dynasty. The date is not distinct on any of the coins, but as that personage flourished 1,200 years ago, it may be concluded that the coins left their primitive mint a long time back. Some Spanish coins appear to bear a date either about the year 1740 or 1770. Above high-water mark at the spot are large piles of charcoal and remains of large fires where the Kaffirs have burnt the wreckage, probably to extract the bolts, etc. There is an idea in the minds of the local Kaffirs that a box of treasure is buried near the spot where the Grosvenor came ashore, but although a stone is said to have been marked to show where it is, there is as yet little clew to the whereabouts of the hidden prize. Nine of the cannon carried by the Grosvenor are lying among the rocks, as well as large quantities of iron ballast."

EXCAVATIONS AT THE SOUTHEAST END OF THE FORUM, ROME.

The excavations at the Forum at Rome are almost entirely completed, as nothing but an embankment of about thirty feet in length remains to be removed. At present this embankment is used to keep up the communication over the Forum, but will later be replaced by a bridge. In the annexed cut, taken from the *Leipziger Illustrirte Zeitung*, the latest excavations of the Forum are shown. On the left hand side we see the small church of SS. Cosma e Damiano, which was built from the ruins of an antique temple in the sixth century, the circular cella of the temple forming the main hall of the church.

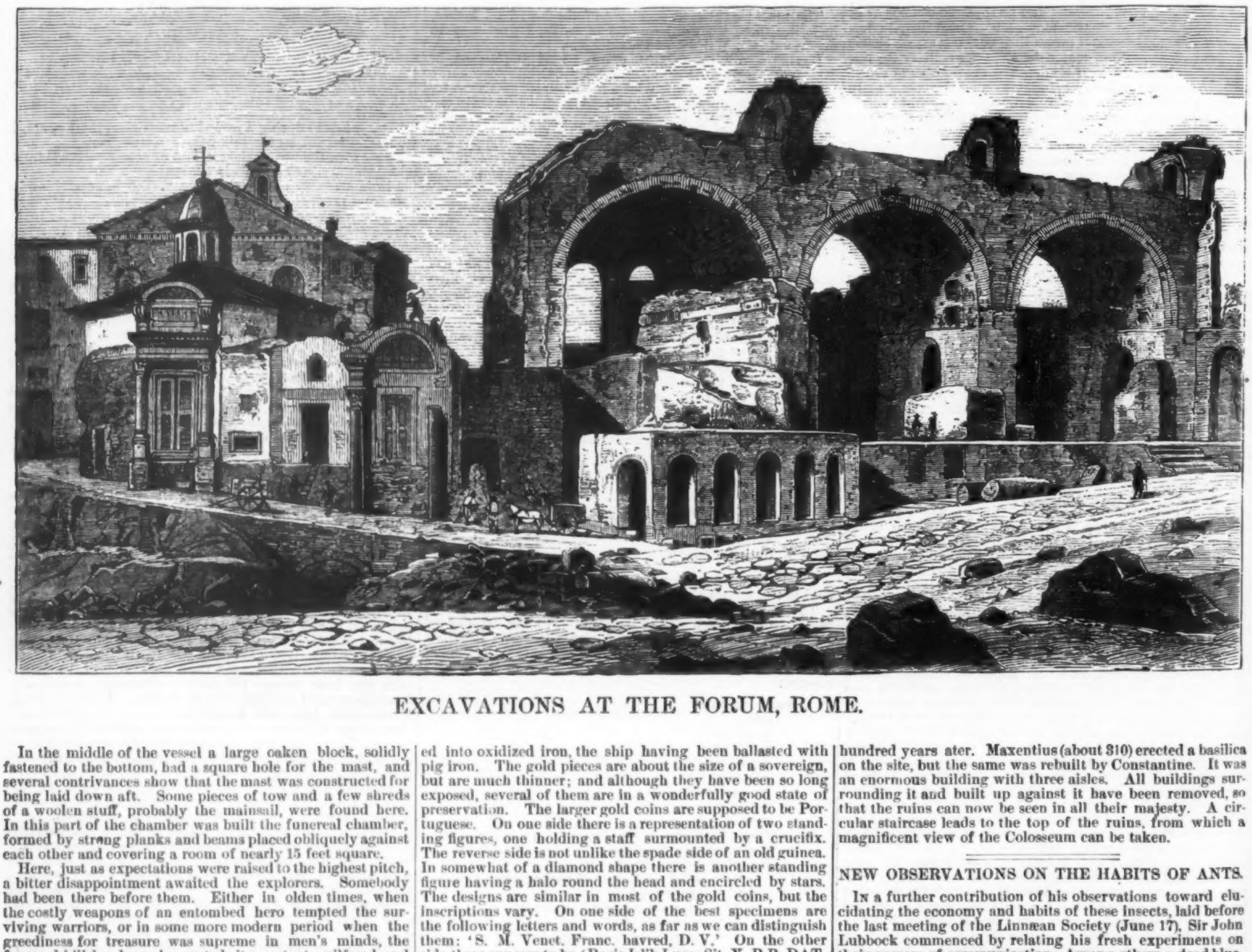
The processions sent out by Gregory to prevent the spreading of the pest started at this church. Pope Julius II. presented it to the Franciscan Friars, who sold it to the Jesuits, as the latter required the excellent "Travertine" blocks to build their church of St. Ignazio.

Of the antique ornaments, the old portal with two porphyry columns and the bronze doors only have been preserved. The church contains some mosaics of the sixth century. From the apse a door leads to the crypt, or subterranean church, containing the bodies of SS. Cosma e Damiano, and of its founder, Felix IV.

These antique buildings were freed from all later additions, of which the Oratory della Via Crucis, from which the processions into the Colosseum started, is being taken down at present. Enormous heaps of rubbish had to be removed to reach the old pavement of the Forum, and during this labor remnants of very handsome mosaic floors were discovered.

Adjoining this church we find the grand vaults of the Basilica of Constantine, which is one of the largest ruins of Rome.

For a long time this building was thought to be the Liberty Temple of Vespasian (A.D. 79), which, however, was destroyed by fire during the reign of Commodus, about one hundred years ater. Maxentius (about 310) erected a basilica on the site, but the same was rebuilt by Constantine. It was an enormous building with three aisles. All buildings surrounding it and built up against it have been removed, so that the ruins can now be seen in all their majesty. A circular staircase leads to the top of the ruins, from which a magnificent view of the Colosseum can be taken.



EXCAVATIONS AT THE FORUM, ROME.

NEW OBSERVATIONS ON THE HABITS OF ANTS.

In a further contribution of his observations toward elucidating the economy and habits of these insects, laid before the last meeting of the Linnæan Society (June 17), Sir John Lubbock commenced by relating his fresh experiments on their powers of communication. Among others a dead bluebottle fly was pinned down, and after vain efforts at removal the selected ant hied home, and emerged with friends who slowly and evidently incredulously followed their guide. The latter starting off at a great pace distanced them, and they returned, again, however, to be informed, come out and at length be coaxed to the prey. In the several experiments with different species of ants and under varied circumstances, these seem to indicate the possession by ants of something approaching language. It is impossible to doubt that the friends were brought out by the first ant, and as she returned empty-handed to the nest the others cannot have been induced to follow merely by observing her proceedings. Hence the conclusion that they possess the power of requesting their friends to come and help them. For other experiments, testing the recognition of relations, although the old ants had absolutely never seen the young ones until the moment, some days after arriving at maturity, they were introduced into the nest, yet in all cases they were undoubtedly recognized as belonging to the community. It would seem, therefore, to be established that the recognition of ants is not personal and individual, and that their harmony is not due to the fact that each ant is acquainted with every other member of the community. It would further

appear from the fact that they recognize their friends even when intoxicated, and that they know the young born in their own nest, even when they have been brought out of the chrysalis by strangers, indicating, therefore, that the recognition is not effected by means of any sign or password. With regard to workers breeding, the additional evidence tends to confirm previously advanced views, that when workers lay eggs males are always the issue of these. Without entering into details of instances it may broadly be affirmed that in the queenless nests males have been produced, and in not a single case has a worker laid eggs which have produced a female, either a queen or a worker. On the contrary, in nests possessing a queen, workers have been abundantly produced. The inference to these curious physiological facts leads to the presumption that, as in the case of bees, so also in ants, some special food is required to develop the female embryo into a queen. In Sir John's nests, while from accidents and other causes many ants are lost during the summer months, in winter, nevertheless, there are few deaths. As to the age attained, specimens of *Formica fusca* and *F. sanguinea*, still lively, are now four and others five years old at least. The behavior to strange queens often results in their being ruthlessly killed; yet as communities are known to have existed for years, queens must occasionally have been adopted. With the view of trying how far dislike and passion might be assuaged by a formal temporary acquaintance, a queen of *F. fusca* was introduced into a queenless nest, but protected by a wire cage, and after some days the latter removed, but the queen was at once attacked. Mr. McCook, nevertheless, relates an instance of a fertile queen of *Crema-togaster lineolata* having been adopted by a colony of the same species.

by any sounds which the ants produced. As opposed to the opinion expressed by M. Dewitz, Sir J. Lubbock regards the ancestral ant as having been aculeate, and that the rudimentary condition of the sting in *Formica* is due to atrophy, perhaps attributable to disuse. A ground plan of the nest of *Lasius niger* is now given by Sir John, which exhibits an intricate, narrow, and winding entrance passage; the main nest cavity is further supported by pillars, and here and there by islands; protected recesses obtain, evidently strategical retreats in times of danger. Studying the relations and treatment of the aphides, or plant lice of the ants, Sir John clearly demonstrates that not only are the aphides kept and protected in the ants' nests, but the eggs of *Aphis* laid outside on the leaf stalks of its food plant in October, when exposed to risks of weather, are carefully brought by the ants into their nests, and afterward tended by them during the long winter months until March, when the young ones are again brought out and placed on the young vegetable shoots. This proves prudential motives, for though our native ants may not lay up such great supplies of winter stores of food as do some of those found abroad, they thus nevertheless take the means to enable them to procure food during the following summer. The fact of European ants not generally laying up abundant stores may be due to the nature of their food. Insects and small animals form portions of their food, and these cannot always be kept fresh. They may also not have learnt the art of building vessels for their honey, probably because their young are not kept in cells like those of the honey bee, and their pupæ do not construct cocoons like those of the humble bee. Relatively to their size our English ants nevertheless store proportionally; for if the little brown garden ant be watched milking their aph-

slate layers of Solenhofen in Bavaria, which being an animal had the appearance of a reptile, but had the characteristic feathers of a bird. The British Museum, London, bought the slab with the impression of the animal for the sum of $3,500. Mr. Richard Owen, the celebrated English anatomist, published a very interesting description and illustration of the peculiar animal, which he called "archæopteryx lithographicus." Nothing further was found of the archæopteryx until 1877, when a second specimen was discovered in Solenhofen, which shows some parts much better than the former one, but also contains imprints of the head and neck, which are missing in the specimen of 1861. From all parts of the world offers were made to secure this precious prize, and Professors Vogt and Zittel immediately interested the German government in the matter. But in the meantime Dr. Werner Siemens, of Berlin, bought the specimen for $5,000, as he feared some foreign museum might secure it before the German government could come to some conclusion. He later sold it to the Prussian government for $4,500. It is now in the Royal Museum at Berlin, and with permission of the directors the well-known artist, Mr. Mutzel, prepared careful drawings of the same, a copy of which we give in the annexed cut, taken from the *Leipziger Illustrirte Zeitung*.

The archæopteryx had the size of a full-grown blackbird. The span from wing to wing of the Berlin specimen is six and one-quarter inches, and the length from the beak to the end of the tail is about eight and one-half inches. The head combines the light build of a bird's skull with the teeth of a reptile, two teeth being visible in the upper and lower jaw of the beak, which resembles that of a parrot. It may seem peculiar that teeth are found in the beak of a bird, but the

THE REPTILE BIRD (*Archæopteryx lithographicus*) DISCOVERED IN THE SLATE LAYERS OF SOLENHOFEN, IN BAVARIA.

Such difference in conduct, Sir John suggests, may be due to his own ants having been living in a republic; for it is affirmed that bees long without a queen are strongly averse to adopt or accept another. Furthermore, if a few ants from a strange nest are put along with a queen they do not attack her, and if other ants are by degrees added the throne is ultimately secured. In pursuance of experiments to test the sense of direction, some ants were trained to go for their food over a wooden bridge made up of segments. Having got accustomed to the way, afterwards when an ant was in the act of crossing, a segment was suddenly reversed in direction, evidently to the ant's discomfiture; she then either turned round, or, after traversing the bridge, would return. When, however, similar pieces of wood were placed between nest and food, and the ant at the middle piece, those at the ends being transposed, the ant was not disconcerted. In other instances a circular paper disk was placed on a paper bridge, and when the ant was on the disk this was revolved, but the ant turned round with the paper. A hat box with holes of entrance and exit pierced at opposite sides was planted across the line to the food; when the ant had entered and the box turned round, the ant likewise wheeled about, evidently retaining her sense of direction. Again, with the insect *en route*, when the disk or box with the ant within was merely shifted to the opposite side of the food without being turned round, the ant did not turn round, but continued in what ought to have been the direction to the food, and evidently was surprised at the result on arrival at the spot where the food had previously been. To ascertain whether ants make sounds audible to one another, the use of the telephone was resorted to, but the results were negative. These experiments may not be conclusive, for the plate of the telephone may be too stiff to be set in vibration

ides, a marked abdominal distention is observable. The paper concludes by the history and technical description of a new species of Australian honey ant. This corroborates Westmael's strange account of the Mexican species; certain individual ants being told off as receptacles for food, in short they become literally animated honey pots.

THE ARCHÆOPTERYX.

No group of vertebrate animals of our present world is so peculiarly confined to a certain organic formation as the birds, for, whereas all other classes of vertebrate animals show intermediate or connecting forms, which combine several characters in a peculiar manner, we know of no such transition types from the birds to the mammalia or from birds to reptiles. It is evident that this deficiency of a connecting link between the birds and the other vertebrate animals is used as a most powerful argument against the theory of Mr. Darwin of the origin of the several species. If the more or less close relation of the several classes of animals is not only imaginative, but a real blood relation, some intermediate forms should exist between the birds and reptiles, as the histological and anatomical development of the reptiles resembles that of birds more than that of any other class of animals, but as no fossil birds having any resemblance to any other kind of animals have been found in the tertiary or upper chalk layers, it is evident that birds owe their existence to a special act of creation. Such were the arguments against the Darwinian theory. It was a most peculiar circumstance that in 1861, a short time after Mr. Darwin's work appeared, and as the fight for the authority of his hypothesis was fought with bitter determination, the skeleton of a singular being was discovered in the

great French naturalist, Geoffroy Saint-Hilaire, discovered the rudiments of teeth in the beaks of parrot embryos, which teeth, however, disappear later. The neck of the archæopteryx rests on the breast, and is curved in the shape of an interrogation point, thus ?. The extremities are of especial interest, for the rear ones are not only exactly like those of a bird, but also possess the characteristics of the feet of climbers, whereas the front extremities are entirely different from those of a bird. In the wing of a bird the end of the wing corresponds with the thumb and the two adjoining fingers of the human hand, whereas the middle bones of the hand are connected, and with the other fingers are inclosed in the skin, in the edge of which the main feathers are set. But this is not so in the archæopteryx, for the upper and lower arm bones resemble those of a bird, but there are more than three fingers, and they are not united. Several of the same, if not all, terminate in strong claws, such as have been observed only on the front extremities of reptiles. The rear extremities of the archæopteryx resemble those of a bird and the front extremities those of a reptile, but the tail combines the characteristic features of a bird and reptile. In a bird the stern feathers are all attached to a single flattened vertebra, whereas the tail of the archæopteryx consists of fourteen vertebræ arranged in a row as in the tails of reptiles, to which twenty-eight feathers, preserved to the finest details, are attached. The animal was entirely covered with feathers, for sixteen feathers can be seen on each wing. It is evident that the flying powers of the animal were not very great, and it appears that it climbed up the trees by means of its claws on its front extremities, and descended in the manner of the flying squirrel, for it does not seem probable that the animal was able to steer well with its long reptile tail.

THE TRUNCATED ARMADILLO.

The armadillos or tatous are at once distinguished from all other mammals by the peculiar bony armor with which their back is protected. This armor is not a consolidated framework, but is composed of several parts, which are so arranged as to allow freedom in the bending of the body. One large shield covers the head, another the shoulders, and another the rump; and between the two last there are several parallel movable bands of the same material. The tail in some cases is covered with successive rings, and in others, as the legs, with mere horny tubercles. All this armor is attached to the skin of the body, and it is made up of numerous many-sided plates placed together as inlaid work. The armadillos have a pointed muzzle, slightly extensible tongue, and powerful claws. They inhabit the warm and hot parts of America, dig burrows, and live upon vegetables, insects, and worms. The genus *dasypus* formerly included all the species, but they are now distributed among several genera. The nine-banded armadillo of Texas to Paraguay is eighteen inches long to the tail, and the body has nine bands between the shield over the shoulders and that over the rump. Other species have respectively three, six, seven, and twelve intermediate bands. The glyptodon, a fossil armadillo, well known to those who visit museums, through the excellent casts made by Prof. Ward, of Rochester, inhabited South America; and its shield might well be compared to a huge cask, being five feet long, and the total length of the animal nine feet. In marked contrast with this is the living Chilian species, the truncated armadillo (*Chlamyphorus truncatus*, Harl.), which is only six inches long, and the smallest member of the family. Its back is covered with a suit of transverse plates of nearly uniform size, and these are attached to the body only along the spine. The body and armor are abruptly truncated behind. What makes the animal appear still shorter is the absence of a tail—or rather the peculiar arrangement of the tail, for it has one, but it is closely united with the body, a very small portion only being detached. The whole of the lower portion of the animal, the neck, the belly, the haunches, and the legs are covered with long silky hair. The animal is found principally to the east of the Cordilleras. It feeds on slugs, insects, and earthworms, and by means of its long and sharp claws it excavates a burrow which extends to a great distance underground. It remains concealed during most of the day, scarcely ever venturing out before night, and even then it does not stray far from its habitation, since, owing to its short legs, it can neither leap nor run swiftly, its only resource when pursued by an enemy is to take refuge in its subterranean galleries. If it happens to be too far away from these, however, it endeavors to excavate a new hole, and often succeeds, for it burrows much more rapidly than the mole. If it cannot escape in this manner, it rolls itself up in a ball like the porcupine and lies immovable. In this position it is very easy of capture.

THE TRUNCATED ARMADILLO AND ITS BURROW.

NEWLY DISCOVERED NERVOUS ENERGY.

During the past year Dr. Brown-Sequard has often noticed that the irritation produced by a transverse section of a base of the brain produces opposite effects upon the nerves which are before and behind the section. Following the lead of these indications, he finds that some parts of the nervous system are able, when irritated, to produce a sudden notable augmentation of the properties, or of the motion or sensitive activities, of other parts of the system.—*Comptes Rendus.*

THE MECHANICAL ACTION OF LIGHTNING.

Within the last few days England has been visited by several thunderstorms of considerable severity, and deaths caused by lightning have taken place in three or four localities. Trees have been rent, animals slain, houses injured, and there is some reason to conclude that the summer of 1880 may become rather remarkable for the manifestations of electric disturbance taking place in Great Britain. Although it is well understood that thunderstorms are always to a certain extent dangerous; and although most buildings, public or private, of abnormal height, are provided with lightning conductors to protect them, very few persons know accurately what lightning is. That portion of the general public which is fairly well informed, holds that a flash of lightning is a discharge of electricity from a cloud to the earth. The country journalist regards it as "a discharge of the electric fluid." The ignorant peasant speaks of a thunderbolt, and believes that an invisible something concealed in a "flash of fire," comes from the sky and slays or rends. If we turn to text books for information we shall find very little. "Lightning," writes Professor Fleeming Jenken, "is an enormous electric spark passing between two clouds, or from a cloud to the earth." We shall see in a moment what it is that Professor Jenken calls a spark, and we shall be able to judge whether the conditions are such that an electric spark and lightning are one and the same thing. But before going further we must ask our readers who may care to peruse this article to think a little for themselves. It is not probable that they can thus find out what a flash of lightning is, and it is certain that we cannot tell them, but we at least show that it is possible to construct a theory concerning the phenomenon which is consistent throughout.

We may start by saying that lightning is unquestionably a form of electrical discharge, and it produces effects in all ways analogous to those produced by a discharge from a Leyden jar or other reservoir of high tension electricity. It has recently been urged that electricity is a mode of force. It is very difficult, though not impossible, to form a mental conception of a pure force, isolated and apart from matter; but be electricity what it may, it makes its presence known to our senses by its effect on matter; and there is, furthermore, reason to believe that matter which may be invisible or imponderable is first acted on before that kind of matter with which mankind is more or less familiar. Let a Leyden jar—one large enough to hold about two quarts of water will answer very well—be fully charged, and then discharged through a sheet of thick pasteboard. If matters are properly managed a hole may be punched in this way through a thickness of about a quarter of an inch. If this hole be examined it will be found that, although the edges may be singed, it has not been burned through, but punched through. The hole will be very like in its character to those made by a charge of No. 9 shot fired at a distance of twenty yards through a similar sheet of pasteboard. It is very difficult to conceive that such a hole has been made by the passage through the pasteboard of a pure force; all the evidence goes to show that something, that is to say, some form of matter, has gone through the cardboard and made the hole. If a piece of the pasteboard target, with one shot hole only on it, and the piece of card punched by the electric spark, were handed to a man who did not know anything of how the holes were made, he would say of both that something, either a shot or a rather blunt metal instrument, had been driven through the material and left the holes behind. There is, however, this to be noted, that in many cases the hole appears as though it had begun within the substance of the paper, and not at one side or both. It has been laid down that when an explanation of any phenomena or occurrence is available which satisfies all the conditions, it is unnecessary and illogical to offer theories based on any second hypothesis. The electrically punched hole is just such a hole as would be made by the passage of something material through the paper, and so far we have reason to believe that something material has passed through. Now, if we compare the effects of a Leyden jar spark with those produced by lightning, we find a strict similarity between them. The lightning is different from the Leyden jar spark not in kind but in magnitude. When stone is ground to powder, or a tree split, we are justified in asserting that matter in some form or other came in contact with the stone and powdered it. It is supposed that trees are split by the production of steam from their juices by the heat of the electric discharge; and when lightning strikes sand it often produces curious tubes of fused quartz called ligurites. But allowing for this, a sufficient number of cases occur in which the effect produced is certainly not due to heat. At first sight these statements will, perhaps, seem to a few of our readers as extremely heterodox. They will say that we have a theory of material thunderbolts, such as the ignorant peasants hold. Our reply is, that there may be thunderbolts and thunderbolts, but that the peasant, according to his lights, has spoken and reasoned wisely. He has assumed that a great hole cannot be dug in the earth unless something of which the soil can take cognizance has operated upon it. We cannot form any conception of a hole being dug in a field by a pure force. Nor can we imagine such a mundane thing as a block of granite reduced to powder save by the impact or influence of something very different from pure force. There may be forms of matter, however, susceptible to the operation of pure forces. We neither assert nor deny that such is the case, but it is more reasonable to suppose that when a stone is shattered or a hole pierced, or an excavation made, it is made by some form of moving matter than by anything else. Lest it should be said that in assuming that the electric spark is a manifestation of matter in motion we are standing alone, we shall support our opinions by the following quotation from Prof. Fleeming Jenken's "Electricity and Magnetism:" "The distribution of electricity over bodies which have points or angles is such that the electric density becomes very great on these points as it would on a very small sphere, even when the potential is not high. The result is a great repulsion of the electricity for itself, or rather a great repulsion between the neighboring parts of the matter charged with it. We then frequently see *the electrified matter passing off in the condition known as the electric spark.*" Again, in another place he writes: "The electricity has such a repulsion for itself that if it accumulates sufficiently the force becomes great enough to break down the pressure of the air, and *highly electrified particles of the conductor and of air fly off the point. Every electrical spark seen is an illustration of this convection. Lightning is one example.*" The italics are ours. We are apparently justified then in saying that the hole was punched in our card by a volley of missiles dispatched from the surface of the ball of the discharger, and that the mechanical effects of lightning are in like manner possibly due to a volley of missiles discharged from the clouds to the earth. It is more than probable that few of our readers, who are not trained electricians, have before heard or seen the statement, which we have just made. Its truth does not admit of direct demonstration, but it does admit of indirect demonstration.

We may now turn our attention to the nature of the missiles with which we have to do. Apparently there is nothing very alarming about them. A thunderbolt may be a very small thing indeed—let us try to give our readers an idea how small. It is not easy to say what the velocity of a flash of lightning may be; but we have to deal particularly with the fact that particles of matter have to be dispatched with a certain velocity like shot from a gun. Let us assume that this velocity is 50,000 miles per second; it is possibly very much more, but 50,000 miles will suffice. Let us suppose that we have one pound of matter moving at 50,000 miles, or 264,000,000 feet per second. The work stored up in our pound of matter will be found by the formula $\frac{Wv^2}{2g}$, and it amounts to 1,089,000,000 foot-pounds, or over 486,100 foot-tons. It is impossible to convey an adequate conception of the mighty force with which we are dealing. Let us suppose that we have a thunderbolt which weighs one ounce moving at 50,000 miles in a second. It would represent 30,000 foot-tons in round numbers, or a force great enough to lift a great ironclad bodily 3 feet. The one hundredth part of an ounce would have stored in it a capacity for doing work amounting to 300 foot tons. It would lift a rock weighing 3 tons 100 feet. A "thunderbolt" weighing as much as a grain of small shot would be competent to demolish a steeple or to rend an oak.

The mechanical action of lightning, then, may be due to the impact of very minute quantities of matter moving at a prodigious velocity. Their energy is due solely to their velocity, and the comparatively isolated range of the influence of lightning is no doubt attributable to the circumstance that the quantities of matter involved are exceedingly minute, and owe their power entirely to their speed. A cannon ball, moving at comparatively small velocity, may stun, and bruise, and batter, and spread destruction over a wide range; but not so the lightning flash. Just as a bullet, fired through a pane of glass, makes a hole in it, so is the action of lightning confined to beaten tracks and narrow strips of paths. We have, it will be noticed, made no attempt to explain why or how electricity imparts velocity to particles of matter. That no one knows. Nor have we said what form of matter our "thunderbolt" is composed of. Possibly molecules of oxygen or hydrogen from the water in the electrified clouds. Nor have we said anything concerning the charge of electricity which, no doubt, accompanies the matter put in motion, and which, by its inductive effects, may kill men or animals without touching them. Electricity is yet enveloped in a cloud of mystery, rifted here and there, but black as night elsewhere. We have endeavored to show that, according to the best authorities, the electric spark is due to matter cast off from conductors; and we have supplemented this by pointing out that the most insignificant quantity of matter, moving at a sufficiently high velocity, can contain enough energy to account for the mechanical effects produced by lightning. If our readers find inconsistencies in the theory, they must not blame us. The theory, as set forth here, is the legitimate deduction from observed phenomena and the writings of the best authorities on electrical science.—*The Engineer.*

The Mowbray Nitro-Glycerine Works at North Adams, Mass., have been blown up three times.

FRANKLIN'S PLACE IN SCIENCE.

FRANKLIN's contributions to science are not limited to his electrical discoveries and inventions. Out of many such that might be mentioned there are two that deserve especial attention. They are (1) the course of storms over the North American continent; (2) the effects of the Gulf Stream.

He relates the circumstances of his meteorological discovery in a letter dated February, 1749: "You desire to know my thoughts about the northeast storms beginning to leeward. Some years ago there was an eclipse of the moon at nine o'clock in the evening, which I intended to observe, but before night a storm blew up at northeast, and continued violent all night and all the next day, the sky thick-clouded, dark, and rainy, so that neither moon nor stars could be seen. The storm did a great deal of damage all along the coast, for we had accounts of it in the newspapers from Boston, Newport, New York, Maryland, and Virginia; but what surprised me was to find in the Boston newspapers an account of an observation of that eclipse made there, for I thought as the storm came from the northeast it must have begun sooner in Boston than with us, and consequently prevented such an observation. I wrote to my brother about it, and he informed me that the eclipse was over there an hour before the storm began. Since which I have made inquiries from time to time of travelers and of my correspondents northeastward and southwestward, and observed the accounts in the newspapers from New England, New York, Maryland, Virginia, and South Carolina, and I find it to be a constant fact that northeast storms begin to leeward, and are often more violent there than to windward. Thus the last October storm, which was with you on the 8th, began on the 7th in Virginia and North Carolina, and was most violent there."

Of late years this observation of Franklin's has been greatly extended. It now appears that almost all the chief atmospheric disturbances of this continent pass in an easterly or northeasterly direction toward the Atlantic Ocean. Nor do they stop on gaining the sea coast. Why should they? In making their way over that ocean, though some may disappear, many reach Europe. It follows, then, that the approach of these may be foretold by telegraph, and that not only in the case of the more intense atmospheric disturbances, but the coming of minor ones, such as are popularly designated waves of heat and cold, and variations of atmospheric pressure, may be predicted. The introduction of the land and ocean telegraphs for this purpose constitutes an epoch in the science of meteorology. Ships about to cross the Atlantic may be forewarned as to the weather they may expect. An exhaustive examination of the whole subject was made by Daniel Draper, director of the New York Meteorological Observatory in the Central Park, and published in his reports of that observatory for the years 1872–73.

2d. Of the Gulf Stream. The existence of this current was long ago detected by the New England fishermen, but they had no idea of its magnificent proportions, its great geographical and climatological importance. These were first brought into view by Franklin. In a memoir read at a meeting of the American Philosophical Society, December, 1785, he states that while he was concerned in the management of the American post office an investigation was had respecting the cause of the long voyages made by the packet ships from England. The merchant ships made much shorter ones. "There happened to be then in London a Nantucket sea captain of my acquaintance, Captain Folger, to whom I communicated the affair. He told me that the difference was owing to this, that the Rhode Island captains were acquainted with the Gulf Stream, which those of the English packets were not. 'In crossing it we have sometimes met and spoken with those packets, who were in the middle of it, and stemming it. We have informed them that they were stemming a current that was against them to the value of three miles an hour, and advised them to cross it and get out of it.' I then observed it was a pity no notice was taken of this current upon the charts, and requested him to mark it out for me, which he readily complied with. I procured it to be engraved by order from the general post office on the old chart of the Atlantic, and copies were sent down to Falmouth for the captains of the packets. Having since crossed this stream several times in passing between America and Europe, I have been attentive to sundry circumstances relating to it by which to know when one is in it. I annex hereto observations made with the thermometer in two voyages. It will appear from them that a thermometer may be a useful instrument to a navigator; since currents coming from the northward into southern seas will probably be found colder than the waters of those seas, as the currents from southern seas into northern are found warmer."

Though Franklin was not the discoverer of the Gulf Stream, he was the first to bring it prominently into notice, to cause a chart of it to be published, to detect its most important characteristic—its high temperature—to introduce the use of the thermometer, and to point out the importance of that instrument in navigation.

In the short compass of this article I have not space to relate many of his minor experiments and observations. There is, however, one that deserves to be referred to, from the influence it has had in optical science. "I took," says Franklin, "a number of little square pieces of broadcloth from a tailor's pattern card of various colors. They were black, deep blue, lighter blue, green, purple, red, yellow, white, and other colors or shades of colors. I laid them all out upon the snow on a bright sunshiny morning. In a few hours (I can not now be exact as to the time) the black, being most warmed by the sun, was sunk so low as to be below the stroke of the sun's rays; the dark blue almost as low; the lighter blue not quite so much as the dark; the other colors less as they were lighter; and the quite white remained on the surface of the snow, not having entered at all. What signifies philosophy that does not apply to some use? May we not learn from hence that black clothes are not so fit to wear in a hot sunny climate as white ones?"

"What signifies philosophy that does not apply to some use?" That is a sentiment characteristic of Franklin, characteristic of the age in which he lived. In truth, the entire scientific and industrial progress of that century is an example of the application of it.—*Dr. John W. Draper, in Harper's Magazine.*

THE NATIONAL MEDICAL LIBRARY.

THE National Medical Library, at Washington, is now the largest distinctively medical library in the world, having grown from about 1,800 volumes at the close of the war, to more than 50,000 bound volumes, and 60,000 pamphlets, with complete files, for a long series of years, of nearly all the medical periodical publications in the world.

THE ZODIACAL LIGHT.

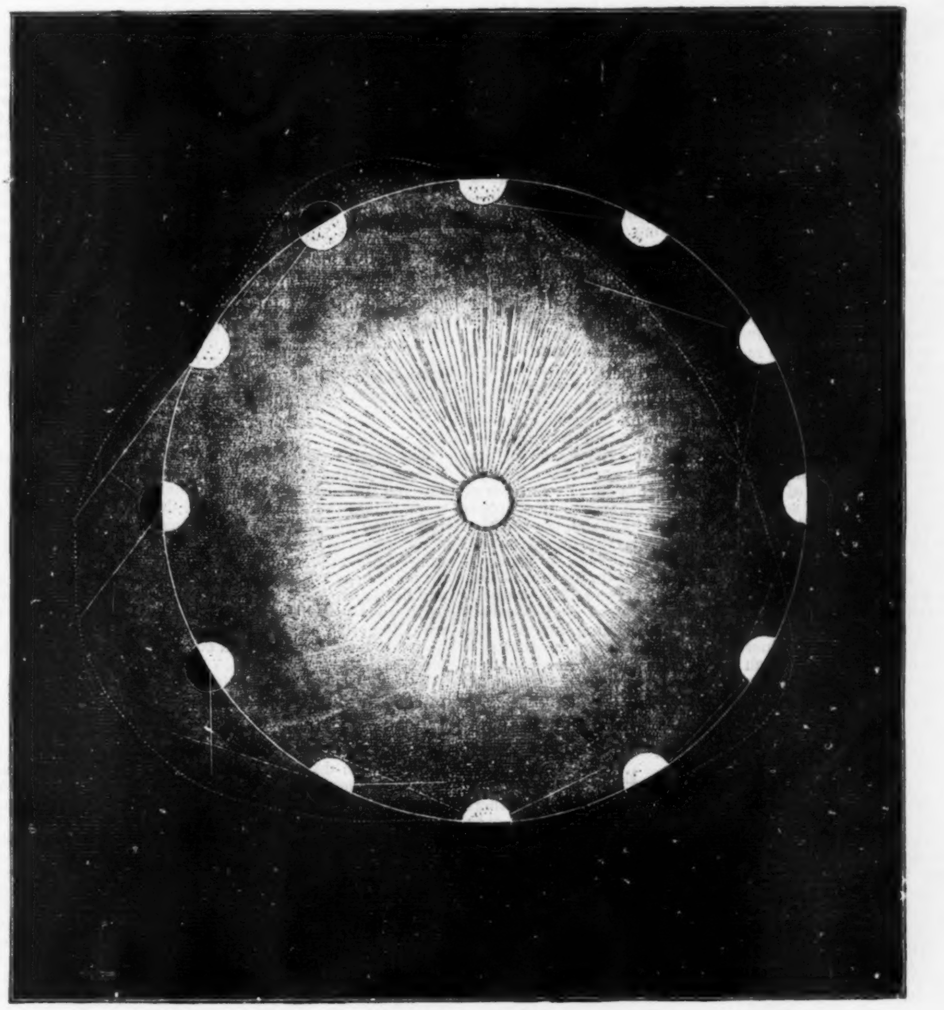
FATHER MARC DECHEVRENS, Director of the Observatory of Zi-Ka-Wei, China, after a series of observations extending from 1875 to 1879, has just published on the subject of the zodiacal light, a remarkable memoir, which forms an important contribution to science. The phenomenon that he describes has remained hitherto so little known that there are still at the present day scientists who consider it an envelope of our planet, while there are others who regard it as a vast extension of the solar atmosphere. Clearer ideas in regard to the subject may be obtained from the facts acquired, and of these we will give an abstract. We should first remark that the observatory of Zi-Ka-Wei, at which these researches have been made, is situated in a remarkably favorable position for the study of the heavens. It is in the middle of an immense plain, at about twenty-five miles from the sea, no irregularities of land surface limiting its horizon, and the air there being exceedingly pure. The first plate of the memoir contains, for a period of four years (and several times in each month), the measurement of the elongations of the point of the eastern cone of the zodiacal light seen in the morning before break of day, and of the elongations of the western cone seen after twilight. A hundred and eighteen drawings were made with great care; and, among the much larger number of detailed descriptions indicating the variations of the phenomenon, we select some of the more characteristic.

During the month of December, 1875, the eastern branch assumed a rapid and unlooked-for development. Its brilliancy was truly extraordinary. It was observed to spread far into the distance without interruption, and to preserve for a length of nearly 40 degrees an almost uniform breadth as far as the constellation Aries. The observation from the evening of the 24th to the morning of the 25th was the most interesting of the series; the phenomenon that night covered nearly three-fourths of the ecliptic (263°). The axis passed a little above this plane, but the sun did not occupy the middle of the band. On the evening of the 24th, on fixing his eyes attentively on the lower portion, it appeared to Father Dechevrens like a nebulous mantle, with ill defined external borders, enveloping a long luminous central band. The brilliancy of the two cones appeared nearly identical, especially at the base, and almost double that of the Milky Way in its most brilliant parts. On the 18th of November, 1876, at 6 o'clock in the morning, the very brilliant lower portions seemed like a mantle from which was escaping a narrow cone proceeding 50° farther, and nearly to Regulus. The brilliant parts towards the horizon contrasted well with the Milky Way. At 4 o'clock in the morning, December, 1877, the light from the east advanced only a little beyond Regulus without reaching the Milky Way. The phenomenon then did not entirely cover the ecliptic, there being a gap of about 60°. On the evening of the 22d, notwithstanding the presence of Venus, and of the light emitted by the moon which was about rising, the zodiacal light was visible as far as the Pleiades. The month of July was the minimum epoch of the phenomenon. In July, 1879, the light was so often observed that the phenomenon may be considered as visible the whole year at Zi-Ka-Wei. From the above *résumé* of the observations, it will be seen that when the two branches are of the same length—from 80° to 90°—the zodiacal light assumes the same form at the two sides of the horizon—that of a lance-head, or of a slightly flattened lens; but when the elongation exceeds 100°, it takes on rather the form of a long band of light of constant breadth, and which is occasionally enveloped at the base by a sort of mantle that is more luminous. The glimmer always appeared to the observer very calm and without any vibration. Its color was always pure white, such as we see it in the Milky Way. This glimmer participated in the apparent diurnal motion of all the stars, and this fact (which has been perfectly established by the Zi-Ka-Wei observers) saps the very base of the systems which assign the terrestrial atmosphere as the seat of the zodiacal light.

It should be remarked that the two branches of the light do not make their appearance in the horizon at the same epoch, nor do they disappear together, but the maximum of elongation takes place at the same moment. The observations on the greatest extent that the elongations of the light can reach are the more interesting in that they agree with observations made in other parts of the world (the Cape of Good Hope and the South Atlantic) by the learned traveler Eylert. From what is known, it may be concluded that the total amplitude may reach 295°. The theoretical views of Father Dechevrens are the same as the well known ones of Laplace, who supposed the zodiacal matter to be composed of the most subtile parts of the primitive nebula, the condensation of which has successively formed the sun and the planets of our system. These molecules, circulating with unknown velocities beyond the atmosphere properly so-called, probably do not agree in velocity with the latter.

In trying to deduce the form of the nebulosity from collected observations, we find it irregular, such as represented in the annexed figure. Its larger axis, or rather its line of greatest dimensions, traverses the ecliptic at two points whose longitude is from 220° to 100°, and this axis is met by the earth in its revolution around the sun in April and in December or January. The sun is not in the center of the figure of the nebulosity, which very appreciably exceeds the terrestrial orbit, and forms a space subtended by an arc of 30° at the summer solstice, and a space almost triple at the winter solstice. Sometimes our planet skirts the borders of the nebulosity, and sometimes it moves through its interior. As regards density we are led to believe that the particles are not uniformly distributed in the mass; they appear to be more compact in the vicinity of the sun, especially in the region situated at the base of the cone, and which has been called by the name of the mantle. The circulation of the matter composing the nebulosity must give it a lenticular form. It is evident that it borrows the light which it emits from the sun. The variations of intensity that are observed may be explained by admitting the opacity of the constituent molecules, and consequently the existence of phases analogous to lunar ones. As to observations made with the polariscope, there is accord between Father Dechevrens and the American astronomer Wright, who has ascertained that the plane of polarization passes through the sun, and that the quantity of polarized light reaches from 15 to 20 per cent. of the total light. This light is solar light reflected by the molecules, as is also shown by spectroscopic observations.

Regarding the passage of the earth through the nebulosity, there is reason to ask whether the temporary obscurations sometimes observed in the daytime may not be due to our globe coming in contact with some of the denser and more opaque portions. The meteoric dusts observed by Prof.



WINTER SOLSTICE. VERNAL EQUINOX. SUMMER SOLSTICE.

THE ZODIACAL LIGHT.

Nordenskjöld in the polar regions, and by other scientists in different countries of the globe, might also proceed from these passages. There is still some uncertainty as to the position of the plane of the nebulosity with respect to that of the ecliptic. In the Zi-Ka-Wei observations we find a slight deviation of the axis of the light, but in two opposite directions. From those which have been made by Heiss at Munster, the axis would seem to be situated on the northern side, but the angle of deviation is also small, while the observations made by another savant in the Southern Atlantic show the extremity of the zodiacal cone at a latitude of 21°. Must we suppose changes so great? This is something that it is important to verify by new researches, and on this subject Father Dechevrens expresses the wish that a determination of the variations of form and extent of the zodiacal light shall be made as often as possible in other meteorological observatories, as it is in that of Zi-Ka-Wei. It is a phenomenon, says he, that is much more frequently visible than is thought. It is important that one should not be satisfied to take observations immediately after twilight or very little before daybreak. Doubtless at these moments the zodiacal light could not escape a somewhat attentive observer; but he would have reason to fear that he might be deceived as to the elongation of the point, since the upper portions of the light are effaced by the lower ones. It is necessary, then, to make observations a second time, when the sun, in sinking below the horizon, will have caused the most luminous portions of the nebulosity to disappear. Then, if the eye be not fatigued, and if one has taken care especially to prepare it for observations by a quarter of an hour's rest, I believe it would be very difficult for him not to succeed in discerning through the constellations (whose principal details should be known) that soft light which is in the form either of a cone, or of a lancehead, or of a narrow band extending to a greater or less distance above the horizon, according to the time of the year and the hour of observation. The great number of problems that the zodiacal nebulosity still presents ought to encourage researches. There should be a possibility of a better determination of the particles of which it is composed. The observations made by the aid of the spectroscope do not agree—in consequence, perhaps, of preconceived ideas. In some of these it has been alleged that lines belonging to the aurora borealis were seen; in others, those belonging to the solar corona; and there are still others which have simply given the lines of the ordinary solar spectrum. There may indeed be some relations existing between the nebulosity and certain showers of shooting stars, which make a more frequent appearance at epochs when it is nearest the ecliptic. The supposition that, at the moment when the earth passes through it, meteoric dusts and cosmic observations occur, is quite admissible, and investigations in this direction may lead to interesting discoveries.

It is here in order to recall the important remark made in 1845, by Father Secchi, in regard to the extraordinarily bright luminous appearance that the nebulosity assumed at the period when the comet of that year was near enough to the perihelion to traverse the solar atmosphere. The increase of light must have been due, according to the illustrious astronomer, to the agitation caused by the comet in that atmosphere. From whence proceeds, says Father Dechevrens, the stability of the zodiacal nebulosity in our system, in the presence of so many bodies whose masses must apparently incessantly disturb and modify its form, the position of its different parts, withdraw them from the sun's attraction and make of them atmospheres for themselves, or nebulosities whose stability can not be durable? On the other hand, is there not reason for seeking to verify Tyndall's hypothesis relative to the zodiacal light, considered as an incommensurable current of ponderable matter flowing in some manner towards the sun, increasing in density in measure as it approaches it, and which might have been formed of meteoric elements designed to serve as a constant aliment to the devouring activity of the central star?

ENSILAGE.*

By O. B. POTTER, Esq.

BORN and bred upon the farm, I now find, like others, after many years of professional and business labor, occupation for a portion of my time, with recreation and health, in agriculture. I am glad to avail myself of the courtesy of the Farmers' Club to state my experience in ensilage, or preserving food for cattle in a green state. So deeply convinced am I from experience, of the importance of this subject to American farmers, that I shall make no apology for urging it upon their immediate attention through this club.

I have practiced this system for three years; have applied it to common fodder corn, red clover, pearl-millet, West Indian millet or Guinea corn, green rye, green oats, and mixed grasses in which clover predominated, with entire success in every case. The last year I preserved about one hundred tons. I have never lost any food whatever thus preserved, but during the whole experiment it has been perfectly preserved, and better than when fed fresh and green from the field. It is eaten up eagerly, and clean, leaf and stalk, without any loss whatever, and stock thus fed exhibit the highest condition of health and thrift. For milch cows, to which I have mainly fed it, it surpasses any other food I have ever tried. It increases the quantity of milk much beyond dried food, and the quality is better than that produced from the same fodder when fed fresh and green from the field.

This is owing, I think, to the fact that it does not scour or bloat the animals, while it retains its natural juices and nutritious qualities in the most digestible form. The process is not unlike that by which sauer kraut is made, and so much is food thus preserved improved, especially for milch cows, that I think no one who understands the process and has facilities for practicing it would, after trial, continue the present method of soiling or feeding fodder crops fresh cut from the field. The process is exceedingly simple and easily practiced. The conditions of success are these:

First.—The preserving pits or receptacles must be wholly air-tight, so that when sealed the air can not come in contact with the food to be preserved.

Second.—The pits must be of such form and dimensions as will best facilitate the settling and compacting of the food into a solid mass, and when opened for feeding, will expose as small a part of the surface to the atmosphere as practicable.

Third.—The fodder must be cut green, when in the best condition, or in bloom, passed immediately through the cutting machine to reduce it to uniform short lengths of not more than one inch, and must at once be deposited and trodden firmly into the pit, sufficient salt being used to render it palatable, but no more. As fermentation, which will commence at once, proceeds, and the mass settles, the cutting and treading in of fresh fodder must be continued from day to day, after an interval of about thirty-six hours, until the pit is filled and settling has nearly ceased.

Fourth.—The pit, as soon as completely filled, and settling has ceased, must be securely sealed to exclude the air wholly, and arrest fermentation, and must be kept so sealed until opened for use. At the risk of prolixity I will state with more detail my own practice.

THE PRESERVING PITS.

I make my pits of hard brick, with 12-inch perpendicular walls, well laid in cement with smooth joints. If the ground is sandy or gravelly, the outside of the walls next the earth is covered with a coat of cement, or the walls are filled in behind with clay or clayey earth to prevent the passage of the air through them. The bottoms are also laid with brick upon the flat in cement. The pits are made from eight to ten feet wide, from sixteen to twenty feet long, and about fifteen feet deep. The deeper the pits the more they will contain in proportion to measurement, owing to greater density of the contents from the weight of the mass above.

In all cases where practicable, pits should be made at least twenty feet deep. The walls are made so smooth upon their inner sides as to offer no obstacle to the settling or compacting of the food by friction of the sides. These pits are made either open at the top and covered with a roof, or arched over under ground, with two necks to each coming up to within one foot of the surface of the ground, through which they are filled, and the necks then sealed with earth. This last construction I have found most convenient in connection with basement stables, to which the food is carried or wheeled by a passage from the pits through the foundation walls of the stable. In this construction I make one pit parallel with this foundation wall, and from the side of this pit most distant from the stable, other pits are made at right angles with and connecting with this by door ways, in such a manner that after the contents of this first or entrance pit is fed out, each of the other row of pits may be opened, one pit at a time, and only the surface of the food at the end of the one pit which is being fed will, at any time, be exposed to the air, until the whole is fed out—and this without opening or disturbing the necks of the pits above, which remain sealed. Any other form or construction of pits which answers the conditions may be used, such as pits or wells open only at the top, the food being put in, and taken out through the top only. Such pits would have one advantage, that successive croppings might be put in the same pit, one above the other, each being sealed with a layer of earth when put in. Where sufficient depth cannot be got above water, pits may be made partly above and partly below the surface, the earth excavated being used to make a broad and firm embankment around them to their tops.

FILLING THE PITS.

The green fodder is drawn from the field as fast as cut, and may be cut in any weather except during rain. After running through the cutting machine, it is deposited and trodden into the pit firmly, until the pit is full. The doorway at the end of this pit having already been closed by placing boards across it upon the inside as the filling progressed, is now sealed tightly by placing other boards, properly fastened, across it, upon the outside of the jambs, and filling the space between the jambs with well compacted earth, so that no air can pass into the pit through this doorway; the outer covers are then placed temporarily upon the necks of this pit above, and covered over with earth to the level of the ground above.

A second, and if the cutting force be large enough, a third pit may then be filled, sealed, and covered like the first. After the pit has been closed about thirty-six hours, the necks must be uncovered and opened. The contents will be found very warm and thoroughly wilted, and upon being now trodden down will occupy less than one-half, and if clover, not more than one-fourth of the pit. The pit should then be filled again, trodden firmly, and covered again temporarily as before.

Each pit should now be opened and refilled as before at intervals of from twenty-four to thirty hours, the contents at each time being trodden down as firmly and evenly as possible, and this should be continued until settling nearly or quite ceases, and the pits are full. Salt should be sprinkled occasionally over the fodder while the pits are being filled. The pits being now full, and settling having nearly or quite ceased, must be immediately and thoroughly sealed over the whole top surface of the fodder, by a well compacted layer of clean earth, not less than six inches thick.

This covering of earth should be afterwards examined at least twice, at intervals of a week or ten days, and any cracks that appear be closed with fresh earth.

A covering of straw or hay, not more than two inches thick, may be laid over the fodder before the earth covering is applied, but this is immaterial other than as a matter of neatness. In feeding, the fodder should be cut down, and fed from one end of the pit in sections of convenient width, the earth being first removed from each section.

If open pits are used, a layer of hay or straw may be put over the pits when filled and sealed, to protect the contents from frost in winter, if necessary. I have not found any pressure or weight upon the fodder, other than the earth covering, required. If additional weight is desired, a heavier covering of earth will accomplish this, and make the sealing at the same time more perfect.

MIXING FODDER IN THE PITS.

Much advantage will be gained by mixing clover and grass in which clover predominates, in the same pit, through fodder corn, millet, or sorghum. The clover becomes, after the first fermentation, a putty-like mass, which fills the interstices in coarser and more fibrous fodder, and thus makes the whole much more compact and weighty than it would otherwise be, while it improves the quality of the food.

Among all our products in the Northern States, there are none which will be more enhanced in value by this system than red clover. By it this is rendered the most profitable, and most easily preserved without detriment, of all our grasses. A well, built up with an eight-inch brick wall in cement, twelve feet in diameter, thirty feet deep, with a roof, windlass, and buckets, will preserve perfectly, and deliver for use the whole clover product of more than twenty acres of fertile land.

I have recently put the fairly heavy clover from sixteen acres into a space twenty-four feet long, thirteen feet wide, and ten feet deep. But the benefit of this system, when applied throughout the country in preserving fodder corn, sorghum, and the large millets will be incalculable. These crops, hitherto the most difficult, uncertain, and expensive to cure and preserve, become the surest, easiest, and least expensive in these respects, while they are among the richest and best milk and butter producing foods known. By this system the whole southern portion of our country, where the tame grasses are not grown, is at once furnished with a means everywhere applicable and easily practicable, by which their cattle may be fed and fattened in winter and summer as well and nearly or quite as cheaply as where tame grasses abound. Who shall say how important an agency corn, sorghum, and clover wells and pits, which will be practically everlasting, and will save two-thirds the labor and all the waste in keeping and preserving these crops, too safely to require insurance, and in one-twentieth of the present space, may not yet have in making this land of liberty, union, and progress, also a land flowing with milk and honey for this and future generations?

* Read before the Farmers' Club of the American Institute.

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TABLE OF CONTENTS.